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Fig. 1. The Engine and two gangs of disc ploughs: shallow ploughing.

Fig. 2. The Ploughs :-Jhao Jungle in the back ground.

CORRIGENDUM.

On page 342 of Vol. VIII Part IV of this Journal *for* 29.43 *read* 2,943 lbs. as nett weight of cotton.

STEAM PLOUGHING EXPERIMENTS IN THE AIRA ESTATE, KHERI, UNITED PROVINCES

BY

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A RECENT bulletin issued by the Bombay Agricultural Department contains some comparative estimates of the cost of steam ploughing by different systems. The writer, Mr. Musto, Agricultural Engineer, arrives at the conclusion that only two systems are worth serious consideration and of these he prefers the double-engine system to the direct-traction system which has come into vogue in recent years. A brief account of some results actually obtained with the latter system may, therefore be of interest.

With the small holdings which are the general rule in the United Provinces, it is obvious that mechanical ploughing must be limited to certain special cases, such as the reclamation of jungle land and the eradication of deep rooted weeds, *e.g.*, *Kans* (*Saccharum spontaneum*) and *Bainsura* (*Pluchea lanceolata*). For these classes of work the direct traction system possesses several advantages, and in fact the high initial cost and unwieldiness of the double-engine system would probably make its use impracticable on account of the relatively small areas.

Sirdar Jogendra Singh, the owner of a large estate in the Kheri district, asked for the assistance of the Agricultural Department in bringing a large area of *Jhao* jungle and grass

land under cultivation. Cultivation in this neighbourhood is extending, but the cost of digging the land by hand is heavy and the process is slow. The land to be ploughed differs considerably from the average of the province, being heavy grass land covered in places with light *Jhao* jungle; the soil being recent alluvium and in places very sandy, was comparatively simple to plough, particularly as it was always moist; but the thick turf, such as is rarely met with in the plains of India, made the work heavy, and special arrangements were necessary to break up the large clods.

The plant used was supplied on hire by Messrs. Burn & Co., and consisted of a Garrett Single Cylinder Tractor of about 25 B. H. P., fitted with extra wide wheels and the usual accessories for direct ploughing. Coal being exceedingly expensive locally, and sufficient wood fuel unobtainable, the tractor was fitted with oil-burning apparatus for liquid fuel. The fuel was obtained from the Asiatic Petroleum Co., and cost 4 annas 6 pies per gallon delivered at the site which was 26 miles by *kachcha* road from the railway. For convenience in transport the oil was packed in ordinary four-gallon kerosene oil tins, the leakage in this way being less than in barrels, and the empty tins, being readily saleable locally.

The ploughs used included three sets of three-disc Chittanoonga ploughs, constructed for use with a tractor ploughing furrows 10″ wide, and capable of ploughing 12″ deep. Deep cultivation not being essential, the actual work done rarely exceeded 8″ in depth, and was frequently less. As a rule, two sets of these ploughs were used—nine furrows proving too much for the engine on this land.

A Ransomes' special tractor plough, with four breasts, was afterwards added for use in the heavier jungle where the roots were a serious hindrance to the disc ploughs.

In order to reduce the large clods formed by both the disc and share ploughs, two disc harrows were afterwards attached behind the ploughs. These were not designed for tractor work, and were purely a makeshift; they answered our purpose

Fig. 1. The result of ploughing typical Jhao Jungle without the cultivator attached.

Fig. 2. The effect of ploughing with the addition of the cultivator.

better than might be expected, in spite of the fact that they were too light and the discs (10″) too small. The discs cut up the heavy sods turned over by the ploughs, and left the land in suitable condition for further cultivation by bullocks, or for weathering. Until these disc-harrows were introduced the land was left so rough that no further cultivation would be possible until thoroughly weathered. A design has now been obtained for a disc cultivator with a double row of discs, suitable for regular use with a tractor.

Our experiments indicated that for this class of work the single cylinder tractor was hardly powerful enough, as even on the best land we could not plough on the top speed. A compound engine of about 40 B. H. P. would probably have done better work.

Ploughing was carried out in the usual way, by opening a centre furrow and then gathering and ploughing round.

An area of about one hundred acres was ploughed, and the following results were obtained on a four hours' trial run, on heavy grass land, after the staff had been trained and a number of minor adjustments made :—

Time (including all stops for water) ...	4 hours.
Area ploughed	9,800 square yards.
Fuel consumption	18·05 gallons crude oil.
Cost at As. 4-6 per gallon	Rs. 5-1-3.
Cost of oil per acre	Rs. 2-9-0.

Establishment.	Rs
Foreman	100 per mensem.
Driver	30 " "
Three ploughmen @ Rs. 10	30 " "
Bullocks and driver for water-cart ...	30 " "
Coolies	24 "
Total establishment ...	214

The area ploughed per month may be put at 100 acres, allowing for an eight hour ploughing day and for a six day week,

plus an allowance of two days for unforeseen stoppages or for shifting to new work.

	Rs.	A.	P.
Cost of establishment per acre	2	2	3
Capital cost of the tractor landed	9,000	0	0
" " ploughs	750	0	0
" " a proper disc cultivator	350	0	0
" " water-carts and accessories ...	400	0	0
TOTAL Rs.	10,500	0	0
Interest, depreciation and repairs at 25 per cent. per annum	2,625	0	0 per annum.

For work of this class a ploughing season of eight months can be safely anticipated, so that, assuming the engine to be idle during the rains (which is not necessarily the case), the depreciation and interest charges amount to Rs. 2,625 for 800 acres ploughed or Rs. 3-4-6 per acre, making a total ploughing cost per acre of Rs. 7-15-9 or in round figures Rs. 8 per acre—as compared to Rs. 15 per acre, the minimum cost of hand-digging to a less depth.

It is quite likely that it would not be possible to work up to this standard in actual practice when ploughing throughout the season, but, on the other hand, better work would be done as the staff gained experience, and it would probably not be necessary to keep a working foreman on Rs. 100 per mensem constantly in attendance. It was found that the native drivers (Sikhs—two were trained) were quite capable of managing the engine and ploughs after training. Supervision was necessary in two directions, firstly, in arranging for stores and oil and for laying out the work so that the tractor worked to advantage (this is primarily a matter for the owner of the land or his agent and requires no technical skill); secondly, the engine and ploughs require periodical inspection to see that they are correctly adjusted and working to advantage. As the staff gain experience, this inspection may be done at longer intervals, as there is little to get out of order if reasonable care is observed.

Crude oil forms a convenient form of fuel for work of this kind on account of its portability and economy in first cost, when the ploughing is done at a distance from a railway station. In addition, a saving of establishment is effected, as no stoker is necessary, and there is an economy in fuel when the engine is stopped, since the oil can be turned off so long as a small head of steam is maintained. Starting from cold, it is first necessary to raise about 5 lbs. steam pressure with wood or other fuel before the oil injector can be started (the oil is sprayed into the fire box by a steam-jet); steam is quickly raised once the oil jet is started, and the time taken is rather less than with coal. It is stated by makers of this type of engine that about 2 lbs. of oil (density ·924 to ·950 @ 60° F., calorific value 19·530 B. T. U.). are required per brake-horse-power hour; no accurate measurements of power were possible under the conditions of these experiments, but this estimate appeared to be fairly correct.

It may be added that the oil-burning apparatus is detachable and that the engine can be fitted to burn coal or wood in about half-an-hour.

Naturally the cost of ploughing per acre will vary enormously with the land to be ploughed, and the amount to be charged for interest and depreciation will always be a matter of opinion. It has been shown, however, that the cost of breaking up virgin land is reasonable, and that it is much less than that of hand-digging.

It may be remarked that the tractor was taken 26 miles on a very bad road, including the crossing of three unbridged streams with sandy beds, and of the Chowka river; for the latter crossing, the tractor was lightened as much as possible and ferried over on a large country boat. To transport a double engine set under these conditions would probably have necessitated the complete dismantling of the engines.

As regards the application of steam power to the eradication of deep-rooted weeds, it may be mentioned that steam-ploughing experiments were carried out in the Banda district by the Public Works Department some thirty years ago, and that large areas

were cleared and put under cultivation. Zemindars and old residents state that these areas are still practically free from *Kans*, and under cultivation, and we have recently had many enquiries as to why Government does not repeat the experiment on other land. Several zemindars having stated that they would be willing to pay a fixed sum per acre for steam-ploughing: it is hoped that funds may be available for this purpose in the near future.

It has already been pointed out by Settlement Officers and others, that the reasons why *Kans* is a curse in Bundelkhand are economic; and experiments at the Orai Farm have shown that it can be practically cleared by deep cultivation, but that this is not feasible with the limited supply of cattle power available. Holdings in Bundelkhand are large, and are likely to remain so on account of the relatively low yield per acre on these black soils—apart from other considerations. Consequently *Kans* cannot be got rid of by hand-digging, as it would be in tracts like Oudh, where the pressure on the land is intense. *Kans* in Bundelkhand has spread to such an extent that in some villages 75 per cent. of the land is out of cultivation. If the *Kans* could be cleared by deep cultivation, there is every reason to believe that for a number of years the land could be kept in order by ordinary *Rabi* cultivation.

In conclusion, I wish to acknowledge my indebtedness to Sirdar Jogendra Singh, on whose land and at whose expense the trials were conducted, and to Mr. Jeffery of Messrs. Burn & Co., in conjunction with whom these experiments were carried out.

AGRICULTURE AND CO-OPERATION IN BURMA.

BY

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THAT the existence of a suitable economic environment is essential to the progress of industrial development has often been noted, and may be regarded as a truism. Like other truisms, however, it is liable to be overlooked in practice, and nowhere more so than in dealing with the industry of agriculture. It is well known that many of the discoveries which have, in the past two centuries, revolutionized industry, were by no means new, and that such as were new failed in many cases to bring profit to their inventors. The inventors produced the ideas, but it was not until the economic and other factors necessary for the proper development of the inventions had been brought into proper relation, that real industrial advance was possible. So much is this the case that at the present time fears are being freely expressed in many quarters lest the organizing agencies and groups of entrepreneurs should gain absolute control of industry, to the complete subjection both of producers and consumers, as ordinarily understood.

The same phenomena may be seen in the history of agriculture. Many of the fathers of English high farming died in poverty, and for much the same reason as many of the early inventors of new industrial processes. Improvements in agricultural processes are not absolutely and entirely independent of their environment. Unless the economic and other conditions under which they are introduced are suitable, they may be expected to fail of success

and bring ruin rather than prosperity upon those who attempt to adopt them. Illustrations of this danger may be seen everywhere. In England, for instance, the high farming of the nineteenth century, probably the best farming the world has ever seen, is failing to maintain itself as the economic conditions which made it possible are disappearing. It is especially important to guard against it in the Indian Empire where, owing to the paucity of credit and general lack of capital among the cultivating population, few, if any, of the latter, are in a position to embark on any experiment the financial success of which is not assured. The traditional methods of the farmer in the East are no doubt antiquated and in sore need of improvement, but they have a definite relation to the farmer's environment and have by long experience been proved capable of providing him with adequate means of obtaining a livelihood, though it may be but a poor one. It has, for instance, in Burma, long been the custom to rail against the people who indulge in shifting or " taungya " cultivation, as if their failure to come down from their hillsides and undertake permanent cultivation on the plains were due simply to an obstinate refusal to take advantage of their opportunities. Enquiry, however, shows that the taungya cutter lives a self-sufficing if poverty-stricken life, and that in his usual condition of complete lack of credit or capital an attempt to change to more permanent methods would probably result also in a change from his present position of self-sufficing independence to one of economic servitude to a money-lender. The history of the canal tracts of the Shwebo and Mandalay districts teaches a similar lesson. Here the most prominent result of the introduction of irrigation has been the enormous increase of debt among the cultivating classes, due to the expenditure requisite for turning their former dry crop lands into paddy fields, funds to meet which were only forthcoming as the result of loans raised at ruinous rates of interest. As a consequence the special intervention of Government has proved necessary in the case of the most recently opened Mon Canals system, in order to provide the requisite credit for financing the change from dry to irrigated cultivation.

The same considerations apply to the improvement of agricultural methods. Every province in India now possesses one or more experimental farms, by means of which it is hoped to bring agricultural progress and its advantages home to the ordinary cultivator. But these farms have little or no relation to the economic environment of the cultivating classes, and the capital expenditure invested in them by Government exceeds anything that the cultivator is likely to be able to afford. The cost for instance of equipping the Hmawbi farm of 400 acres in Lower Burma is estimated at Rs. 85,000, or Rs. 210 per acre, and it is possible that even this figure may be exceeded. No cultivator can afford capital expenditure on this scale. Moreover, with the financial support of Government behind them, the recurring expenditure on staff and general working expenses of these farms is also far in excess of that which any cultivator could undertake, at any rate in a country of small holders, such as Burma is at the present day and is likely to continue to be.

It, therefore, by no means follows that improvements in agricultural methods whose advantages appear to be established on the Government farms, will possess the same merits when followed by the indigenous cultivator. The Government farms may in this respect be compared to an electric generating station producing a current of high voltage dangerous to the small consumer until it has passed through a converter which will reduce it to one suitable to his requirements. The results obtained on the farms may thus be of the greatest scientific value but still be useless to the average farmer because they are not applicable to the environment in which he is compelled to work.

If, therefore, any real agricultural progress is to be secured, one of two things must happen; either the improvements worked out on the farms must be so converted as to be brought into direct relation with the economic environment of the cultivator, or that economic environment must be modified so as to enable it to assimilate the improvements. To the effectual carrying out of the first process the experts of the Government Agricultural

Department can no doubt contribute, and their control and supervision will be as necessary and valuable as is the control of the engineers of an electric generating station over the conversion of the high voltage current. The machinery must, however, be different, and will not be found in the ordinary methods suitable to an experimental farm. Some outside organization therefore becomes essential, having relation both to the farm from which the improvements come and to the cultivator for whom they are to be made available.

The second process lies beyond the ken of the ordinary agricultural expert. The expert is in fact in an almost identical position with the industrial inventor, though by virtue of the financial support of Government he is free from the ruin which awaits the latter, should he fail to control the economic factors necessary for the commercial success of his invention. He is not necessarily possessed of organizing ability, and it would thus appear that in agriculture no less than in the industrial world there is a danger that progress will, despite the introduction of better methods of production, mean simply the loss of his independence by the producer, and his subjection to the autocratic control of a class of entrepreneurs.

That such should be the first outcome of agricultural progress is not likely to be regarded with equanimity in any country, certainly not in the Indian Empire where the maintenance of the agricultural classes in a condition of sturdy independence is one of the cardinal points in the policy of Government. Luckily there is an alternative to the domination of the entrepreneur in agriculture, and that is to be found in the organization of these classes by themselves, the need for the organizing skill of the entrepreneur being thus eliminated. This organization is to be found in the development of agricultural co-operation. Doubts have often been expressed as to whether, in fact, the cultivating classes, generally speaking, possess this power of self-organization, but a study of the results achieved during the past 50 years in Europe will soon dispel any such gloomy forebodings. The marvellous progress which has followed on the introduction of

the co-operative system to Asiatic countries and particularly in Burma and in the other provinces of the Indian Empire in the space of a few years goes far to show that it is as applicable in the Eastern hemisphere as it has proved to be in the Western. In fact it would appear that just as no limit can at present be placed on the progressive productivity of the earth under scientific methods of cultivation, so is there no limit to the development of co-operative organization among cultivators, and there is no department of their professional or social life which cannot be brought within the sphere of its beneficent influence. In any scheme for agricultural development therefore, the inculcation of improved methods of cultivation or stock breeding and the teaching of co-operation are of equal importance. If anything, the need of the latter is the more urgent, inasmuch as the organized agriculturist may be expected of his own motion to seek out and adopt improved methods, while his neighbour in isolation is likely to reject them even though they may be brought to his doors. Only where both factors are shewing vigorous life, can the final aim of all rural development be attained, namely, the growth of a vigorous, full, and independent social life in country districts, giving as many opportunities for self-improvement and recreation as the more meretricious attractions of the towns. The Irish definition of a true rural life policy, "better farming, better business, better living," would in fact appear to be of world-wide application.

In the West it has been found by experience that the assistance of the State is most effective if its direct intervention be confined to better farming, to the provision of travelling instructors, farm institutes, information bureaus, and other methods of agricultural education; while the organization of the farmers on co-operative lines is left to private effort, backed by state subsidies and, as a necessary consequence of the latter, subjected to some measure of state supervision.

Conditions in the East and West are, however, widely different. In the West, society was originally constituted on the principle that the possession of property involved corresponding

obligations, and the majority of the duties now regarded as falling under the heads of local administration and social service were for centuries regularly fulfilled by the possessors of property, particularly of property in land, without any countervailing remuneration except the enjoyment of that possession. The political power and influence thus exercised by the landed proprietors was highly valued and it became the object of all those who secured wealth in trade or commerce to obtain estates in land and, merging themselves in the squirearchy or aristocracy, carry on the principles laid down by their predecessors, with whom they desired to be identified.

With the more complex national life of modern times, more especially of those subsequent to the industrial revolution, large land-owners have lost much of their political power, and *the majority of the unpaid duties formerly discharged by them*, particularly in the sphere of administration, are now separately provided for by the central Government, but the old principle *that property brings corresponding responsibility and obligations* has survived the loss of political power, and has even *extended* its influence over the leisured classes, *which have sprung up as* the result of the profits made in industry and commerce in modern times without attempting to merge themselves in the feudal landowning class of the past.

The result is that in the wealthy upper and middle classes of modern England there is a well nigh unlimited supply of private effort, which can be continually drawn on for the organization of philanthropic or patriotic schemes.

There is an elasticity and vigour about private enterprise which is not always to be found in state action, for the latter must necessarily proceed on somewhat rigid and formal lines and is, therefore, peculiarly liable to be throttled by an excess of routine. Hence it comes that by general consent in the development of co-operation as well as in the case of other social activities which are at the present time helping forward the progress of the nation, private and unofficial organizations are preferred to those directly administered by the State.

In the East, at any rate in Burma, conditions are different. Property and social influence, until the time of the British annexation, had never been divorced from official position, and the principle that private wealth, quite as much as the possession of official status, involved duties to the people, never had an opportunity of being recognised. Further, though wealth has greatly increased under British rule it is still small as compared with Western standards, and there does not exist as yet any leisured class possessed of sufficient means for its requirements and thereby able to devote itself whole-heartedly to the cause of social service. It is not that social service is regarded as unnecessary. That is far from being the case, but few individuals can afford to devote much time or money to it. Their own future and that of their family after them demands their labour for the greater part of their working day, and the result is that although a considerable amount of local effort among a man's own neighbours and in his own town or village may be obtainable, the personnel for the creation and management of large unofficial organizations for extended action, like those of Europe, is not forthcoming and is not likely to be forthcoming for many years to come.

Under these circumstances it is impracticable to rely on local effort for the establishment of central provincial organisations, whether for co-operative propaganda or for any other purpose; and, in as much as central organizations are necessary for the carrying out of any large scheme, the direct intervention of Government for their establishment becomes a necessity.

But though the initiative at the first introduction of the co-operative movement into an Asiatic country like Burma, and the central organization for its control as it progresses, must thus be the affair of Government, yet the considerations which in the West have led to reliance on private effort as the most satisfactory motive force still retain their value, and the growth of such private effort, first in the administration of individual societies, and thereafter for the co-ordination and supervision of the movement generally, may be regarded as the best test of its vitality.

From the application of such a test co-operation, in Burma at any rate, has no reason to draw back. It is now eight years only since its first introduction into the Province, and already the framework of a complete organization of the agricultural classes on co-operative lines is making its appearance, of which the most remarkable feature is the spontaneous character of its growth. Burma owes a debt of gratitude to its present Registrar of Co-operative Societies which it would be impossible to overestimate, and one of the main causes of the success of his administration has been the fact that he has never sought to go constitution-mongering or to impose a cut-and-dried scheme of organization based on foreign precedents upon the country. He has been content to sow the seed, and once the plant has taken root in the bed prepared by him, he has been quick to perceive the shoots thrown out by it and to guide their growth on sound and productive lines. The result is that the co-operative movement has definitely Burman characteristics of its own, and instead of being an exotic may be regarded as an indigenous production thoroughly suited to the soil in which it has to grow.

Surprises there have been in the past, in its development, even to those who have watched it from close quarters, though most of them have proved pleasant ones; and even now it is not possible to foretell with any accuracy the exact details of the future structure. But a brief description of the framework of organization already created may be of interest. The basis of the structure is the local village Society, based on the unlimited liability of all its members. These Societies, to the number of 20 or thereabouts lying within an area of 8 miles or more from a common centre, form a Union, each constituent Society of which is surety for the loans contracted by the rest, to the extent of the outside loans which it itself has accepted. These Unions are the unofficial driving force of the movement. Through their elders and the Union clerk they instruct, supervise, and generally control the working of their affiliated Societies. For the better realization of these objects three or more Unions combine to maintain an Inspector paid for from Union funds which, in their

turn, are provided by a Union rate levied upon the subordinate Societies. The activities of the Unions do not stop short at the organization of credit, and it is through their agency that other branches of co-operative effort—such as sale, purchase, or cattle insurance—are being organized, sometimes by the founding of separate Societies, sometimes by the direct action of the Union alone. The Union is thus taking much the same place in Burmese co-operation as that occupied by the 'Syndicat agricole' in France, though the organization of the two bodies is altogether different. As Unions become numerous in any district a further development is appearing, in a district conference, meeting twice a year. This is a new venture, tentatively started in the early months of 1913, but which has now received the definite approval of the movement at the Biennial Provincial Conference in August last.

These district conferences are to meet twice a year,---once in January when representatives of Unions and Societies only attend to discuss administrative and other matters germane to the progress of the movement in their district,—but the second meeting, in April, is the important one and that which marks the real step in advance. Here the Deputy Commissioner is the chairman, and all district officials are ex-officio members, and the movement is thus brought into a definite relation with the ordinary administrative authorities. The resolutions passed at the preliminary district conference in January are here discussed and voted on, and other resolutions may also be put to the meeting, provided that they have previously been approved by the Registrar as suitable for discussion. Agricultural development is already accepted as a regular item on the agenda of the conference, and there is no reason why sanitation, education, and other subjects of importance to the improvement of country life should not also in time find their place upon its programme.

Lastly, there is the biennial Provincial Agricultural and Co-operative Conference, held in Mandalay, where decisions which have been accepted at local conferences may receive the sanction of the whole movement, and general lines of policy on various

questions can be laid down. Throughout this organization, from the individual Society up to the Provincial Conference, the voting power, and therefore the final decision on any subject brought up for consideration, rests with the general body of co-operators. They may indeed be restrained from dealing with any subject at these meetings, but they cannot be forced to adopt a resolution of which they disapprove. If this is so, it may be asked where Government control comes in. In the first place, the secretariat, both of the district and of the Provincial Conferences, is purely official. Without the tacit consent of the Registrar, therefore, no subject can be dealt with at these assemblies. And, in the second place, the Registrar retains complete control over the borrowing powers of all Societies—and also of audit. No Society may contract any loan without his sanction, and even where Societies possess a cash credit upon which they may draw at will from the Central Bank, the limits of that credit are fixed by him. The auditing staff consists of the Registrar and his assistants, an Assistant Registrar, and a *number of Junior Assistant Registrars. It is through the staff that applications for loans reach the Registrar, and unless he is* fully satisfied as to the working of any Society, he will not sanction the funds asked for, and may even withdraw the sanctions formerly granted or, if the circumstances warrant it, direct that the Society be wound up. All bye-laws or modifications of existing bye-laws must be sanctioned by him, and no Society is registered unless it satisfies him that it is likely to work successfully and on proper lines. The control of the Registrar therefore, even in the case of fully organized districts, remains complete, both in the case of credit and of other branches of co-operative effort. Where internal organization is absent or only just beginning to appear, it is all powerful. In the case of co-operative sale, for instance, the enlistment of the services of the Registrar, as agent to make preliminary arrangements with the large consumers, is essential to the carrying through of any considerable business.

While therefore it is too early to say with confidence that a complete financial organization of the agricultural classes in

Burma is in sight, it can certainly be maintained that the framework of it, now making its appearance in the best organized districts, of Shwebo, Pakokku, Mandalay, Kyaukse and Sagaing, represents a very satisfactory solution of the problem of Co-operation in the East, namely, the combination of Government control and responsibility for the main lines of policy, with full opportunities for unofficial and private effort in the administration and development of district and local organizations. Organized on the lines described above, the cultivators of the Province should find little difficulty in modifying their economic environment so as to enable them to adopt with success any improvement in agricultural methods which the Agricultural Department may have to teach them.

While the cultivators on their part are thus engaged in fitting themselves for the reception and practice of new ideas, the Agricultural Department is on its side attempting to find the most practical means of converting its improvements into forms most suited to their adoption by the cultivators.

That the same apparent advance has been made by it in this direction as has already been remarked upon in the case of co-operative organization, is certainly not true, but, as has been pointed out, the business organization must come first before a general movement for better farming can be expected to succeed. Still, now that the framework of the future co-operative structure is making its appearance, it is time for the Department to be moving. Even when the organization of a district is complete it is improbable that a close working connection with the large experimental farms will be obtainable without some intermediary. Just as the agriculturist is not necessarily an organizer, so co-operative organizers are not necessarily advanced agriculturists, even though they come from agricultural classes. Instances could be given from Western countries, from France, Ireland and Italy, where the two roles have been combined, to the great advantage of the agricultural department, but conditions are not the same in Burma as in Europe, and the combination of agricultural instructor and co-operative organizer in the same

person is at present impracticable, a fact which has been recognized by both Agricultural and Co-operative Departmental Conferences.

Opportunities for the introduction of sudden and drastic alterations in the cultivation of any district are rare, and when they do occur, depend largely upon the initiative of the district officers for their realisation.

A case in point is the introduction of groundnut into the Pakokku District—due to the initiative of a Deputy Commissioner who took advantage of a year of bad crops and distributed 20,000 baskets of groundnut seed to cultivators by way of agricultural advances. This vigorous action caused much heart searching to the Financial Department, many of whose well-intentioned regulations had been set at naught, but the experiment succeeded from the first, the advances were all repaid, and groundnut has now become the chief mainstay of a large portion of the district.

Such chances of distinction however present themselves but seldom, and the work of an Agricultural Department is as a rule of a more humdrum type, since in the majority of cases it is not so much by the introduction of new staple crops that agricultural advance is to be secured as by the progressive improvement of those already established in the country. The advantages of seed selection are already known to every paddy cultivator and in a rough and ready fashion its practice may be said to be universal in Burma. The inner niceties of pure line breeding are, however, beyond the ordinary cultivators' powers, and for this the Province must depend at present upon the experimental farms. It by no means follows however that the pure breeds producing the best results upon the soils of Hmawbi or Mandalay will also prove the best elsewhere. Local seed farms to discover the varieties best suited to each locality are therefore necessary and upon them the scientific methods of the experimental farms must again be brought to bear. The closest and most intimate relations between these seed farms and the cultivators are necessary if they are to fulfil their proper mission, and for this purpose it is desirable that wherever possible they

should be in unofficial hands and under unofficial management. Until, however, it has been demonstrated that the seedsman's calling may be as profitable in the east as in the west, no petty cultivator can safely undertake it on his own account, and, once again, it is from co-operative organizations that the first steps in this direction are to be looked for. That the organized cultivators will be equal to this demand upon their energies is probable, but, again, it is not certain, and in any case there are the parts of the country where co-operation is still either non-existent or in its infancy. In the latter case the necessary seedfarms must be run by the Agricultural Department. To adopt this course is not necessarily to abandon the view advanced above that in the absence of co-operative effort little or no advance is to be expected. That co-operation will finally spread throughout the Province may be taken as certain, and the fact that departmental seedfarms are in existence, on which the best varieties for local conditions have been tested and developed, will facilitate the appearance of co-operative farms when the organization of the local farmers is sufficiently complete. Thus the establishment of seedfarms, partly run by the department and partly belonging to members of co-operative organizations, is the policy of the Agricultural Department. In both cases intermediaries will be required to look after them, and for this purpose a commencement has been made with the provision of a staff of District Agriculturists, recruited from the departments where a considerable knowledge of indigenous methods of agriculture is to be obtained and also trained in the methods of seed selection obtaining on the experimental farms.

It is hoped that as these men get to know their districts and acquire the confidence of the people, they may act as a very efficient link between the cultivators and the experts of the department on the farms, an aim which is most likely to be realised in the case of those who have before their appointment served their apprenticeship to co-operation. Such candidates are therefore, if otherwise qualified, regarded with most favour in selecting District Agriculturists.

This machinery for closer touch between the Agricultural Department and the organized cultivators is a new venture and is only just beginning to be set up. How far it will realise the expectations that have been set out is therefore still to be seen, but, though still an experiment, it would appear to be one on the right lines, not only for its primary purpose but also for inducing the closest possible relations between the sister departments of agriculture and co-operation.

These relations are already made intimate in other ways. Departmental Conferences of the staff of both Departments are held half-yearly. The Director of Agriculture has an official status at that of the Co-operative Department, as Assistant to the Registrar with all but independent powers for nearly half the Province, while at that of the Agricultural Department the Registrar of Co-operative Societies is present as an ex-officio visitor. The head of each department can therefore make his influence felt in the counsels of the other, and the rural development administration of the Province is thus as it were in the hands of a board of two members, each of whom, while supreme in his own branch, is also in a position to have his say in the conduct of the affairs of the other. In view of the close connection which is inevitable between agriculture and co-operation, such a division of authority might appear to be anomalous and be thought likely to give rise to friction. But, like most anomalies, in practice it has worked well. Both departments are under the Financial Commissioner, who can thus secure uniformity of policy and correlate diverging tendencies should they occur. This subjection of the two departments most concerned with rural development to the chief revenue authority of the Province is no doubt justifiable if improvements in business organization and farming be regarded solely from the financial point of view as producing a wealthier population and therefore one more able to contribute funds for the improvement of administration. But a full rural life policy consists not only of better business and better farming. The third branch, of better living, though only capable of realisation when some considerable advance has been

made towards the attainment of the others, is of equal importance with, and perhaps, in the long run, of even greater value than, the rest, as being the end to which the others are but the means. As the organization of the agricultural classes develops, therefore, it is to be expected that the means whereby better living may be secured will also come within their sphere of action. From organized care of the health of cattle, already a feature in the co-operative programme, to the organized care of the health of cattle owners is but a short transition; once sanitation comes within the purview of the co-operative movement, education may be expected to follow. The Revenue Department may invoke the aid of co-operation for the discovery of the best and least inconvenient methods of collecting the annual revenue, and even the police may perhaps recognise that an organization of the people for the purpose of increasing their wealth and well-being may also be able to contribute to the problem of how the country side is to be rendered safe from thieves, robbers and bad characters of every kind. All these are obviously connected with the question of better living and the development of a rural civilization in country districts. When these expectations begin to be fulfilled, then it is likely that the incongruity of the subjection of rural development to the revenue collecting branch of the administration will be acknowledged, and a separate department will be created, having full control, on its co-operative side, of the business organization of the people, and, on its agricultural side, of the improvement of their most important industry. True co-ordination between the first two branches of the rural life policy would thus be secured. The head of such a department, moreover, would have, by virtue of his position, direct access to the Local Government and also treat on equal terms with the heads of other great departments, while the organized rural population, meeting in their provincial conference presided over by the Lieutenant-Governor or his deputy, and in district conferences with the Deputy Commissioner as chairman, would maintain a direct means of contact between every branch of the administration and themselves, and

thus secure that true co-operation between unofficial effort and official rule which is the secret of good government and the special aim of the British Empire in the East.—A dream perhaps but at least not more extravagant to-day than the present achievement of co-operation would have appeared in the eyes of residents in Burma twenty years ago.

THE ORGANIZATION OF AGRICULTURE BY THE DEPARTMENT OF AGRICULTURE IN IRELAND AND ITS APPLICATION TO THE CONDITIONS OF THE BOMBAY PRESIDENCY.*

THE question which no doubt will arise in the mind of every one who has read the title of this paper is "What has Ireland got to do with the Bombay Presidency and how can conditions there be applicable to those of this country?"

I have tried to keep this very natural criticism in mind, and I hope you will be convinced that the similarity of conditions is so remarkable that the experience of Ireland can be of the greatest value to us in Bombay.

The Agricultural branch of the Department of Technical Instruction in Ireland was started in 1900, and the first duty undertaken by the staff was to get in touch with the County Councils, of which there are 33, and to study the rural economy and agriculture of the island.

The conclusions arrived at after a preliminary survey of the situation was completed, were (1) that owing to the backwardness of the people and the averseness of the small holder to leave his land, a permanent and comprehensive system of agricultural education in the widest sense of the term was necessary, (2) that as far as practicable the Department should devote a large part of its funds as an endowment to aid local authorities in the development of agriculture, (3) that the Department should retain the direction of the development by local authorities in its own hands only in so far as was necessary to secure

* A paper read by Mr. W. W. Smart, I.C.S., Acting Director of Agriculture, Bombay Presidency, at the Provincial Agricultural Conference held at Poona, September, 1913.

co-ordination and a uniform policy, on lines laid down by the central authority.

The organization which was evolved to secure the above objects, I will describe as briefly as possible, and then proceed to give in outline my ideas as to how it could be adapted to this Presidency. It is hardly necessary to state that my views must be regarded as personal, and in no way official.

Each of the 33 County Councils levies a rate of $\frac{1}{2}d.$ to $1d.$ in the pound on the rateable value of the holdings within its limits. The levy of this rate is optional under the Act, but since the second year after the passing of the Act every Council has levied the rate.

In 1907 the average amount raised and devoted to agricultural purposes by each Council was about Rs. 15,000. Each Council for the purpose of the Agricultural Department's work appoints a Committee of Agriculture, composed, partly of members of the Council, and partly of other persons. To this Committee the Council usually delegates full powers, subject to the approval of the Department, for the administration of funds placed at its disposal.

The relations between officers of the Department and the Committees have been excellent. The members and officers are constantly in conference, either at the local meetings or at the head offices of the Department, to discuss the details of, and the arrangements for, carrying out the work. Each Committee is invited by the Department to submit its views on the working of the schemes laid down for their adoption, before the commencement of each agricultural year. Suggestions made by them in the great majority of cases have been adopted, and if a County Committee considers itself aggrieved by some action of the Department, the Committee can ventilate its grievance through the Council of Agriculture, a body appointed specially for this purpose, and to whom the Department must answer if it ignores public opinion.

The amount of work done and money expended by the County Committees has steadily increased. The total amount

raised last year by the voluntary rate (for the most part now equal to one penny in the pound), was about £43,000 or 6,45,000 rupees,—or an average for each Council of about Rs. 19,545.

In the early years the Department recouped County Committees one-half the cost of each piece of work, except in the case of a number of poorer counties whose proportion was increased to five-ninths. Later the Department's contribution has been three-fifths of the actual cost of each scheme undertaken in the poorer counties, and five-ninths in all other counties. In addition however, the Department in the case of certain live stock schemes pays the whole of the fees and expenses of the judges and veterinary surgeons who act at local shows, as well as the fees and expenses of the judges in connection with the award of prizes for good farming and well-kept cottages. The Department also pays the whole salary of itinerant instructors of agriculture, the cost of pioneer lectures, and of special investigations and enquiries.

In 1907 the Department contributed in all £48,000 or Rs. 7,20,000, as compared with nearly £32,000 or Rs. 4,80,000 raised from rates. Thus the average amount of the joint fund available to be spent by each Agricultural Committee in each county was Rs. 36,345, though it must be understood distinctly that each county receives a grant in proportion to the sum raised by the voluntary rate. The guiding principle of the Department is to help those who help themselves.

I will now proceed to describe the system under which the joint fund is administered.

The work to be performed by the County Committees is limited by certain schemes which are drawn up for their guidance by the Department. They may adopt any one or more of them, but they cannot spend money outside them. These schemes comprise improvements in the breeds of cattle and other animals; itinerant instruction in agricultural subjects; prizes for cottages and farms; subsidies to live stock shows; field experiments and demonstrations with manures and seeds; systematic instruction in winter schools of agriculture; instruction in the keeping and

marketing of poultry; instruction in horticulture including the purchase and distribution of trees at cost price; instruction in bee-keeping and home butter-making.

I will give the main points of one or two of these schemes, in order to give you an idea of their nature.

The scheme for encouraging improvement in the breeds of cattle, aims at encouraging the breeding or introduction of pure bred bulls or registered dairy bulls of a high degree of excellence, and inducing associations of farmers or persons of means to purchase high class bulls for the use of small farmers.

The details of the scheme are framed by a sub-committee of the County Committee in accordance with the conditions of the Department's general scheme. The money sanctioned by the Committee with the approval of the Department, is to be applied solely in providing premiums for bulls, though sometimes loans are given to individuals for the purchase of bulls. The pedigree, age and health of the bulls must be in accordance with the rules laid down. The premiums range from Rs. 150 to 225 and are renewed each year on proof that the bulls have been fruitful and are in satisfactory condition. These bulls are often purchased at cattle shows from those selected as fit by the Department. The owner of a bull who receives a premium must advertise the fact, and the bull must serve not less than 30 to 40 cows other than those that are the property of the owner of the bull. The service fee which the owner may charge is from annas twelve to Rs. 1-14 per cow, until the minimum of 30 or 40 cows have been served, when he may charge what he likes. The owner must abide by rules, laid down by the County Committee, as to care of the bull, exclusion of other bulls from his herd, etc. The bull must be made available for the service of the cows of genuine farmers living in the county in the order in which they are presented, and it can be branded or inspected by officers of the Department, if necessary.

The scheme for instruction in agriculture provides that the County Committee should appoint one or more instructors, and the Department do their best to supply qualified persons. These

instructors do the same work as our district agricultural overseers, but, in addition, deliver regular lectures, and often hold winter classes for 4 days in each week during the winter months. The teaching in the latter is much the same as the theoretical part of the curriculum of our Vernacular Agricultural School, with a small amount only of practical demonstration.

The year's work is carried out as follows :—

The agricultural year commences in autumn, but in June the Department circularise all the County Committees, inviting their views on the work of the previous year. The views of the Department's instructors also are obtained, and where matters of national importance are involved or expert advice is required, advisory committees of experts are invited to help in the deliberations.

A programme in outline is prepared by these committees, and the details are left for each local committee to settle as it sees fit.

Early in August these outline schemes are laid before the Agricultural Board, with a statement of the amount of money which it is estimated will be required from the Department's fund

(1) to meet the cost of central administration,
(2) to meet the Department's contribution to the funds of the County Committees.

When the latter has been voted by the Board, a conference of the secretaries of the Committees is held to discuss any new provisions in the schemes and to fix the dates for meetings of the Committees, at which the Department's inspectors must attend to help the Committees to arrange the details of the programme of work for the ensuing agricultural year. The schemes which the Committees desire to adopt and the provincial allotment of funds proposed are intimated to the Department, which then intimates its approval, as well as the maximum of the departmental contribution for the year. The appointment of sub-committees to assist the statutory Committees is a most important element in the successful carrying out of the chemes. The

County Committees meet, as a rule, once a month and a representative of the Department always attends the first meeting and as many subsequent ones as possible.

To obtain an insight into the working of County Committees I visited Tyrone, where a good type of Committee is to be found. There were 29 members on the Committee and the following staff were employed by it:

(1) A permanent secretary appointed by the Committee.

(2) An Itinerant Instructor in Agriculture.

(3) An Assistant Instructor in Agriculture.

(4) An Itinerant Instructor in Horticulture and Bee-keeping.

(5) An Itinerant Instructress in Poultry-keeping.

The Assistant Instructor in Agriculture spent his time from 25th October to 5th March in giving courses in agriculture at three centres.

The Itinerant Instructor in Agriculture gave lectures during the winter months, at 13 centres, on such subjects as the use and purchase of manures and storage of farmyard manure, foods and feeding, the management of the potato crop, and the management of grass lands. He distributed leaflets, laid out demonstration plots at the centres where lectures were given, attended shows, and went about giving advice and help to farmers on all sorts of subjects. Besides, he visited demonstration and experimental plots and obtained the results of them.

The Horticultural Instructor gave lectures, in the winter, at 14 centres, and spent the rest of his time distributing trees and visiting gardens—to help the owners—and three demonstration plots in his charge.

The Itinerant Instructress in Poultry-keeping gave lectures at 10 centres in 6 months, and judging from the figures of average attendance, her lectures were better appreciated than those of her colleagues. The rest of her time was taken up in visiting farms, where premiums had been paid to the owners for keeping pedigree birds and for distributing their eggs for setting, and in giving advice as to diseases of poultry and their proper housing.

The Secretary was the most important member of the staff, and on him largely depended the success of the work. Powers of organization and, in a country like Ireland, much tact, are required.

The Bombay Department of Agriculture is not behind Ireland in the matter of higher agricultural instruction.

Our college is equipped as well as the branch of the Royal College of Science devoted to Agriculture. The multiplication of Vernacular Agricultural Schools in the Presidency which is taking place, will soon put us on a footing of equality with Ireland in this respect. Our agricultural stations for experimental purposes are more numerous and better equipped. It is in the organization of their district staff, and the system by which the small farmer is interested and led to co-operate in schemes for agricultural improvement, that Ireland seems to me to be so far ahead of this Presidency.

The difficulties with which the department had to contend were as great or greater than exist here. I will quote freely from a report on this subject.

"A factor which has to be taken into consideration in devising a system of agricultural education is the fact that in Ireland there is an extraordinary desire on the part of young men of the country to escape from farm life. Their education is all directed towards fitting them for occupations of a wholly different character, and the brightest of the family receives an education often at the expense of the son who is to succeed the father. It is impracticable to bring the farmer himself to school, and therefore the only way he can be brought into contact with the application of science to agriculture, is by sending round instructors to give lectures in the evenings, to visit holdings during the day, and discuss privately with the occupiers the various problems which confront them in their practice. With the agriculture of Ireland in a backward condition, where the smartest sons forsake the land, where the holdings are often too small to be economically managed, where the farmers' financial resources are very limited, where a system of agricultural

credit, often of the worst possible description, exists, and where the people have been taught that improvement of their land may mean an increase in rent, the Commission will realise that the Department had very real difficulties to face."

Might not these words have been written of the conditions in this Presidency, and cannot the remarkable advance made in Ireland serve as a lesson to us? When I add that in Ireland there are over half a million holdings, of which 350,000 do not exceed 30 acres, and 220,000 do not exceed 15 acres; that out of 550,000 agricultural holdings 390,000 peasant proprietors have been created by advances from the State of 120 millions sterling, and only 160,000 remain to be created, I think, gentlemen, you will agree with me that the conditions are extraordinarily alike.

I will proceed to outline my ideas, as to how the Irish system could be adopted in this Presidency.

I would give District Local Boards the power, by a special Act, to raise an agricultural rate of one pie to 3 pies in the rupee on the land revenue, or $\frac{1}{12}$th to $\frac{1}{4}$ of the local rate levied at present, and to appoint a Committee composed partly of its own members and partly of members of Taluka Local Boards. I would suggest that the Committee be constituted as follows:—$\frac{1}{2}$ the members elected by the District Local Board from its own members, $\frac{1}{4}$ elected by Taluka Local Boards from their own members and $\frac{1}{4}$ nominated by the Collector from persons specially interested in agriculture.

Government might contribute $\frac{1}{2}$ to $\frac{2}{3}$rds the amount raised by the District Local Board towards each scheme of agricultural advancement adopted by the Committee and approved by the Department,—in addition to paying the salary and allowances of the existing Divisional Inspectors of Agriculture and their staff, and of the District Agricultural Overseer. These officers would serve as links between the Department and the Agricultural Committees.

When 10 out of 19 districts in the Presidency had appointed Agricultural Committees and raised a rate, I would appoint a Provincial Council of Agriculture composed of members

elected by the District Agricultural Committee—say, one member for every 5,000 rupees raised in any district—and of which the Director of Agriculture, the Deputy and Extra Deputy Directors, and certain members of the Agricultural College staff should be ex-officio members.

The Council should have the power to invite to its deliberations any experts in agriculture or trade, whenever it thought fit. It would sanction the allocation of contributions from Government to Agricultural Committees, consider representations from them, and serve as an advisory and controlling authority in all matters connected with the administration of the joint funds.

The Director and the Department must retain exclusive control of all experimental work, but, in spite of the fact that I am a sun-dried bureaucrat, specially cured by some years' service in Upper Sind I believe that the advancement of agriculture amongst the agricultural community can be secured only by the closest co-operation with the rayats and their leaders, who must be given, subject only to such restrictions as exist in Ireland, the control of the money which they raise voluntarily. Many will object that no District Local Board will come forward to raise a local rate of even one pie ; that the imposition of such a rate would be unpopular, and that Agricultural Associations should perform the functions of the Agricultural Committees which I propose. No one would have believed that in a poor country like Ireland, much poorer, taking everything into account, than this Presidency, a voluntary rate would be imposed by every Council within two years of the passing of the Act. If the nature of the scheme proposed and the benefit to be derived by the cultivators be explained to them, I believe that in certain districts of the Presidency there will be no difficulty in raising a cess of one pie, and that other districts would soon follow suit.

In the Chopada Taluka of East Khandesh district half a lakh of rupees was raised by voluntary subscriptions, chiefly from landowners and cultivators, for the creation of schools, agricultural education, and the improvement of agriculture. The example of

this Taluka is, I understand, being followed by others in the district.

The money was raised by the people for the people, and as long as that principle is maintained, I have seen that money is forthcoming readily. The amount of money raised by Agricultural Associations for shows and other purposes during the last 2 years has amounted to Rs. 15,000, and the largest sum raised at one time was Rs. 4,000.

Agricultural Associations have done much pioneer work for the Department in helping to spread interest in agricultural improvements. They have received assistance from the Department which has been given willingly, and I am very grateful to the members of many associations who have taken the greatest trouble in collecting subscriptions, organizing shows, conducting demonstrations and preaching the adoption of new methods by word and deed. It is unnecessary to state the amount of good work performed by such associations as the Deccan Agricultural Association, the Broach, Dharwar and Kolaba District Associations and many others. But these associations are as conscious of the lack of regular funds and staff as I am, and I am convinced that no regular and sustained progress is possible without both.

The establishment of Agricultural Committees will not mean the death of Agricultural Associations in the Presidency, any more than it has meant this in Ireland. The associations in Ireland have received support and a new lease of life from the establishment of the Committees, and there is plenty of work remaining for associations to carry out, which is suited to their constitution. I refer to such activities as the holding of shows, the publication of agricultural literature, the holding of meetings at which papers are read and discussed and the undertaking of small experiments by members.

In the future, I hope to see associations established to encourage the breeding and registration of pedigree stock ; for the improvement of horticulture and the packing and marketing of fruit ; for the establishment of a breed of poultry worthy of the name, and for many other objects

You will find appended to this paper, a statement of the amount of revenue derived from the one anna cess in each district of the Presidency and the amount which could be raised by a special agricultural rate of one pie in the rupee on the land revenue. The figures are based on those of the year 1911—12. It also shows the amount available as a joint fund, on the assumption that Government contribute half the sum raised in each district.

A rich district like East Khandesh, would have nearly Rs. 23,000 to spend yearly on different schemes of agricultural improvement, and I will indicate what could be done to benefit the rayat by an Agricultural Committee, with such a sum annually at its disposal.

It could maintain a demonstration farm chiefly devoted to demonstrating the advantages of improved methods of tillage, the sowing of selected seed, the conservation of farmyard manure, the steeping of the seeds of cereals in copper sulphate—a practice followed by all good farmers in Europe—and the value of a proper rotation of crops.

Similar demonstrations could be carried out by subsidies to selected farmers in each of the remaining 9 talukas.

At head-quarters, or a suitable centre in the district, and forming part of the demonstration farm, I would have a depôt for the storage of seed, implements and their spare parts, and a workshop for the manufacture of implements and their repair, where cultivators could get repairs carried out and learn to execute simple repairs themselves. In every taluka I would have a sub-depôt for the stocking of implements and spare parts.

In addition to the present Agricultural Overseer paid by the Department, I would appoint a graduate in agriculture with experience, who would be in charge of the demonstration farm in the rains and spend his time from December to May in touring through the district, holding classes for 14 days at certain centres for teaching agriculture and accounts, etc., to the sons of agriculturists who have passed through the course at the rural schools.

Owing to the late decision of Government, agricultural readers and everything but the three R's. have been abolished in the curriculum of rural schools.

The son of the cultivator is to attend school at 4 or 5 years of age and to complete his education at the age of 8 or 9. It is expected that he will be required to help his father in the fields at that age. Is there not a danger that after 3 or 4 years of herding cattle or working in the fields, he will have forgotten all he learnt at school, unless he is got hold of by an experienced teacher and taught that his knowledge of the three R's. can be of practical use to him, in enabling him to become a good farmer and to remain in touch with the larger world outside his own village and district? If we give an education to the ordinary village boy, which at the age of 20 will enable him just to sign his name and perhaps to call himself "literate" at the next census, the money spent on his education will be wasted.

Perhaps allowances might be given out of the joint fund later on, to primary school teachers who attend a course of agriculture at the college and qualify themselves to teach the simple principles underlying good husbandry, in night and hot weather classes. In Belgium some such system exists.

In addition to the chief itinerant graduate, three assistants could be appointed, one for each sub-division. These men could be given a specially constructed cart, in which apparatus for demonstrations of the use of implements and the teaching of the elementary facts of plant life, insect pests, manuring, feeding of stock, etc., could be carried—and classes held in all the chief villages of their charge.

They would supervise also the demonstration plots and the management of sub-depôts for the distribution of seed and implements. Handsome contributions towards shows of agricultural stock and produce, the payment of premiums to the owners of stud bulls and selected growers and distributors of improved seed, and scholarships for boys selected to attend the Vernacular Agricultural School at Loni Kalbhor, could be given.

Lastly a boring staff, making bores in existing wells and prospecting for new wells at cost price, could be maintained for the benefit of cultivators.

I have appended to this paper a sample budget which might be adopted by an Agricultural Committee in East Khandesh. It is a rough estimate and intended only to be suggestive, and no doubt there are many points which would require modification.

For the first few years much of the fund would be used up in capital expenditure.

If this paper succeeds in arousing the interest of this Conference in a system of agricultural organization which has been of immense benefit to Ireland, I shall have accomplished something. If I succeed further in inducing this Conference to pass a resolution in favour of some practical steps being taken to introduce a similar system into this Presidency, I shall have done much; because, what is approved by a Conference of gentlemen representing the agriculture of every district, must carry great weight and command serious attention.

[The analogy between Irish and Indian administrative problems is well known to be in many respects a close one, but in considering the kind of organization required for agricultural development the difference between the economics of the two countries—caused by the fact that Ireland lies at the doors of the greatest market in the world for the sale of agricultural products and the purchase of machinery, while India has to pay a heavy freight on both—must be borne in mind; as also the fact that in Ireland new practices are constantly being put to the economic test by educated farmers, who thus play the part of a very great number of local economic experiment stations.

It may well be that while the possibilities of economic improvement in Ireland are sufficiently numerous and obvious to warrant the creation of a complete organization for their general demonstration, the economic advantage of such possibilities in India requires to be thoroughly established by exceptionally careful investigation before such general demonstration is advisable.

The reputation of Agricultural Science in many parts of India has undoubtedly suffered in the past from the recommendation of practices the economic advantages of which have been insufficient to warrant the expenditure necessary to establish them, and a general expansion of the educational side of an Indian Agricultural Department would appear to be rarely warranted unless preceded by a previous thorough equipment for local scientific and economic investigation.

It seems necessary to sound this warning note lest Indian Departments may be seduced by the glamour of Irish successes to the dangerous course of unduly multiplying staff and demonstration before the spade-work of experiment and research has been done.—(Editor.)]

APPENDIX—I.

No.	Name of District.	Local rate.	1 pie rate.	Government contribution.	Total of cols. 4 and 5.
1	2	3	4	5	6
	Northern Division.				
		Rs.	Rs.	Rs.	Rs.
1	Ahmedabad	40,336	3,361	1,680	5,041
2	Kaira	64,294	5,358	2,679	8,037
3	Panch Mahals	5,258	438	219	657
4	Broach	179,563	14,964	7,482	22,446
5	Surat	170,710	14,226	7,113	21,339
6	*Thana*	*102,645*	*8,554*	*4,277*	12,831
	Central Division.				
7	Ahmednagar	102,422	8,535	4,267	12,802
8	East Khandesh	183,853	15,321	7,660	22,981
9	West "	98,776	8,231	4,115	12,346
10	Nasik	100,997	8,416	4,208	12,624
11	Poona	105,488	8,791	4,395	13,186
12	Satara	177,839	14,820	7,410	22,230
13	Sholapur	85,237	7,103	3,551	10,654
	Southern Division.				
14	Belgaum	112,940	9.412	4,706	14,118
15	Bijapur	110,645	9,220	4,610	13,830
16	Dharwar	166,476	13,873	6,936	20,809
17	Kanara ...	60,233	5,019	2,509	7,528
18	Kolaba	98,047	8,171	4,085	12,256
19	Ratnagiri	61,096	5,091	2,545	7,636
	Total ...	...	168,904	84,447	253,351

APPENDIX—II.

Annual recurring cost of demonstration farm of 30 acres	1,500
Annual cost of Head Quarter Depôt for distribution of seed, implements and their repair	880
9 Taluka Depôts { Rent...	540
9 Taluka Depôts { Watchman and contingencies	1,080
9 Taluka demonstration plots at Rs. 100 per annum	900
Itinerant Graduate of Agriculture at farm in rains and on tourin open season @ Rs. 150 per month	1,800
3 Assistants on Rs. 50 per month	1,800
4 specially trained peons on Rs. 10 per month	480
Travelling Allowance of travelling officers	840
Carriage of apparatus	400
Secretary on Rs. 50 per month	600
Clerk to same Rs. 15 per month	180
Contingencies for officers	350
	11,350
Contributions to shows	5,000
Scholarships to send ten boys to Agricultural Vernacular School ...	750
Loss on distribution of seed, &c.	600
Premiums to 20 stud bulls @ Rs. 60 per annum	1,200
Premiums to 20 registered growers of improved seed @ Rs. 100 per annum ...	2,000
Boring staff for carrying out boring at cost price for farmers	1,800
Balance in hand	300
	23,000

NOTES ON THE FODDER PROBLEM IN INDIA,

ARRANGED BY

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In Vol. II, Part II of the Agricultural Journal of India (April 1907), there appeared from the pen of Mr F. G. Sly, C.S.I., I.C.S., then Officiating Inspector-General of Agriculture in India, an article on "The Trial of Exotic Drought-resisting Plants in India." After an exhaustive account of experiments made, Mr. Sly summed up his conclusions as follows :—

"With the experience of the past as a guide I would strongly deprecate any further extensive trials of exotic drought-resisting plants. The only possible chance of success seems to be in arid tracts, such as Sind, Rajputana and the Western Punjab and, even in these tracts I entirely agree with the opinion of the Director of the Botanical Survey that there is much more promise in the extension of the indigenous salt-bushes and other plants than in the trial of exotics. It is certain that the introduction of drought-resisting plants such as Australian salt-bushes can never form a remedy for the heavy mortality of cattle during famines over the greater part of India."

The conclusions arrived at by Mr. Sly were accepted by the Government of India as conclusive, so far as the introduction of exotic drought-resisting plants was concerned, and their opinion was conveyed to the Secretary of State for India in the following words: "Experiments have been carried out with such plants, but these have proved entire failures and no good seems likely to be gained by a repetition of the experiments. The Government

of India are advised that in the selection of a suitable species of drought-resisting plant for India, it is necessary not merely that the species should be capable of resisting great drought habitually, but that it should, at one and the same time, be capable not merely of existing but of flourishing both under a full monsoon and with complete absence of the monsoon, or, in technical words, the species should be simultaneously xerophilous and hygrophilous. Very few species, if any, have both qualifications, and the Australian species referred to are not possessed of both. In the habitually dry regions of India or Burma, the introduction of exotics is superfluous as there already exist in such areas xerophilous species native to those areas, which species are said to be much better adapted to their environment than exotics would be, and enquiries have been made from Australia regarding Indian species which might be introduced into Australia. In the regions of India which, normally, are subjected to the monsoon influences but only occasionally, when the monsoon current fails, suffer from drought; neither the indigenous xerophilous plants of the dry areas of India nor corresponding species of any other area of the world could be expected to succeed.

"The impossibility of introducing into India from Australia drought-resisting plants superior to indigenous species has, therefore, been accepted, but improvement of fodder resources has not on that account been neglected. Investigations are being carried out in some Provinces on the following lines :—

(*a*) botanical investigations of indigenous fodder grasses;
(*b*) preservation of fodder in the dry state and as ensilage;
(*c*) improvement of pasture land."

This pronouncement together with Mr. Sly's article elicited from Sir William Wedderburn, Bart., who has always evinced the keenest interest in the subject, the criticism that all the unsuccessful experiments reported by Mr. Sly were made in localities subject to monsoon rains and not in arid tracts of India. He advised, therefore, that experiments with drought-resisting fodder plants should be made in Sind where there are wide tracts of dry alkali lands and the rainfall is scanty. He

suggested also that such indigenous drought-resisting plants as *Salsola foetida* should be tried in parts of the country where cattle have suffered from want of food.

Enquiries addressed to the Deputy Director of Agriculture in Sind elicited the fact that Rhodes grass, Wonder grass and *Paspalum dilatatum* have been under experiment in Sind without giving any results. This confirmed the view already expressed that any further trial of exotic drought-resisting plants was to be deprecated.

With regard to the suggestion that indigenous drought-resisting plants such as *Salsola foetida* should be tried in parts of the country where cattle had suffered from lack of food, enquiries addressed to local officers elicited the information that, except in the United Provinces and Madras, where they failed, no Province has made experiments with plants like *Salsola foetida* nor do they wish to give them a trial.

In 1902, experiments were made in the United Provinces to grow *Salsola foetida, Haloxylon recurvum, Kochia indica, Haloxylon multiflorum* and *Suæda maritima* on *usar* soils (both highly alkaline and slightly alkaline). They were all unsuccessful. The details of these experiments are given in Agricultural Ledger No. 5 of 1902.

At Saidapet in Madras, in the year 1882, some varieties of Salsola were tried experimentally, but the general result was poor growth and tendency to seed prematurely.

Salsola foetida grows naturally in the Punjab, Rajputana, Sind, and Baluchistan and is valued as a camel fodder. It is said that cattle other than camels will not eat it. It, therefore, seems useless to extend operations for its introduction into other parts of India.

In view of the great interest which is taken in the question of the fodder supply of India, it is considered advisable that the efforts made in this direction by the various Provinces, should be placed on record. The object of the following notes is, therefore, to detail, for the information of the interested public, the lines on which the conservation and improvement of fodder supplies

have been or are being attempted. For the information here recorded, I am indebted to the various Provincial Directors of Agriculture to whom I would here express my thanks for the very complete details, as affecting their Provinces, they have given me. This article is practically a compilation of their reports, as it appears to me that the detailed efforts of each particular Province in this direction will have much more interest for the public than a general summary.

In a subsequent article, I hope to deal with the more general aspects of the problem and to make available for the general public the results of the discussion of the fodder problem by the Indian Board of Forestry at their meeting at Dehra Dun in March 1913, and those arrived at by the Board of Agriculture in India which discussed the question at their meeting at Coimbatore in December.

United Provinces.—The position in the United Provinces is thus stated by the Hon'ble Mr. Hailey, the Director of Land Records and Agriculture :—

"In dealing with the action taken by the Agricultural Department for the improvement of the fodder supply, particularly in the dry parts of the Provinces, it is difficult to isolate the question from the more general question of the improvement of cultivation. The principal sources of fodder supply in these Provinces, where grazing is limited, are the secondary products of food crops, *e.g.*, *bhusa*, chopped *juar* and *bajra* stalks. The conditions of food supply and fodder supply are so closely connected that any measure taken to improve the former affects equally the latter. One of the most important is the extension of irrigation facilities ; and the attention of the Department has been directed for some years past to extending the area irrigable from wells, for which purpose a large staff of borers is maintained. Every addition to the irrigation facilities means a possible increase in the food supply and conversely in the fodder supply ; and renders the supply more independent of the character of the season. Compared with the results so obtained, the outcome of direct measures to increase the fodder supply is probably insignificant,

and this applies with particular force to the dry areas. Viewed in this light, nothing that the Agricultural Department can undertake can be comparable with the results obtained from the work of the Irrigation Department.

"In certain other respects, too, the Agricultural Department can only play a minor part in improving the fodder supply in comparison with other Departments, though it is usually associated with them in their action. The question of improving the fodder supply in these Provinces was debated at considerable length at a conference summoned in 1909 to consider matters relating to the supply of cattle and milk products in the United Provinces. The two principal points considered were the preservation of grazing grounds by the remission of land revenue, a penal rate being assessed if the conditions are broken, and the possibility of obtaining railway concessions for the transport of hay from the forest areas. These are measures of great importance as affecting the fodder supply, but beyond the scope of the Agricultural Department. It may be mentioned that in these Provinces, including the typically dry tract of Bundelkhand, there are considerable forest areas, and the question of the supply of hay and extending the grazing grounds is primarily a matter for the Forest Department. The functions of the Agricultural Department are often purely advisory and though it may claim to have initiated certain measures, the carrying out of them has rested with other Departments. The question is in fact one which should be regarded from a Provincial rather than a Departmental point of view. The action of a single department does not give an adequate conspectus of measures taken by the Local Government, and it is frequently difficult to mark off the work of one department from that of another.

"The main sources of fodder supply may be summarised under the following heads in the order of their importance :—

(*a*) Secondary products of food crops, *e.g.*, *bhusa*, *karbi* (chopped *juar* or *bajra*).

(*b*) Grass and other natural products.

(*c*) Fodder crops.

"(*a*) There is little doubt that in these Provinces in which the land is closely cultivated and the grazing land in most parts very limited, the secondary products of food crops form the principal supply of fodder for cattle. This does not apply to sheep and goats, which are left to pick up what they can from the fallow fields or uncultivated patches. As already noted, most measures which tend to the better cultivation of the land or the improvement or protection from drought of the food supply will indirectly tend to improve the fodder supply. It is not possible to explicitly set out the action taken by the Agricultural Department towards this end. Foremost among the measures taken may be put the assistance given in well construction and improvement, which has increased the produce of considerable areas and protected them from drought.

"(*b*) Over the submontane portions of the Provinces, considerable tracts of grazing land remain intact; and the villagers are admitted to grazing in parts of the Government forests. The area available for grazing in this part of the Provinces could be greatly increased, if any special necessity arose, by opening the forests to grazing. In the famine of 1907-08, all Government forests were opened for free cutting and removal of grass from the 20th November 1907 to end of July 1908; and grazing was permitted on privileged rates. Elsewhere, grazing land has been reduced to narrow limits. The question of preserving the remaining grazings is mainly economic; and the desirability of taking steps for their conservation has been considered from time to time. In the more closely cultivated areas, very little can be done; but where there is more waste land the Agricultural Department has taken steps to improve it for grazing purposes.

"Experiments have been undertaken for improving eroded ravine land, partly with a view to providing pasturage for cattle, and partly for plantations of trees. Similar experiments have

been made to start fuel and fodder reserves on waste land or on land on the margin of cultivation. This land is either 'usar' or poor land standing above ravines which is improved by embanking or terracing. The 'babul' itself affords valuable fodder in dry years; its leaves being eaten readily by the cattle and the green pods by the sheep and goats. A good deal of work on the same lines has been and is being carried out by Court of Wards' Estates and large zemindars. In one estate an area of a square mile was fenced and planted and an excellent crop of grass raised in the first year; in another 'dhak' was successfully grown. The question of establishing 'babul' plantations on a large scale on poor land or on the borders of ravines is being taken up by the Forest Department. It is recognised that in Bundelkhand an extension of such plantations would afford very valuable pasturage for cattle in seasons of crop failure.

"In co-operation with the Forest Department efforts have been made to organise a supply of grass from the forest areas to the cultivated tracts. During the famine of 1907-08 hay was pressed and baled and exported in very large quantities to the districts suffering from a fodder famine.

"Endeavours have been made by the officers of the Department to spread knowledge as to the best methods of preserving fodder by ensilage.

"Lastly under this head may be mentioned efforts to introduce and popularise new grasses for fodder purposes, such as guinea grass.

"Several Court of Wards' Estates have experimented successfully with these grasses.

"(*c*) Fodder crops are principally grown in the western districts where the size and quality of the holdings and the resources of the cultivators permit of considerable areas being sown with these crops. The Cattle Conference mentioned above considered the question of fodder crops and were of the opinion that a natural development was taking place, and could not suggest any means of assisting the development, except by a

reduction of the canal rate for such crops. On representations being made by the Director the irrigation rate was lowered, and the reduction was followed by a very considerable extension of the practice of irrigating these crops resulting in a largely increased produce. The extent to which fodder crops are grown in these Provinces may be gathered from the fact that in 1909-10 and 1910-11, 10,92,259 and 10,87,563 acres respectively were grown. Instruction has been given as to the best methods of preserving these fodder crops by ensilage.

"The Department have endeavoured to introduce the *Sorghum saccharatum* which has considerable advantages over the *Sorghum vulgare* commonly put down. The fodder crops grown by the cultivators are mainly grown in the rains and endeavours have been made to introduce crops which will give a feed during the cold weather or early months of the hot weather. Different kinds of lucerne have been tried, seed has been distributed from the farms, and information published regarding the best methods of its cultivation. In 1910-11, the canal returns show 7,426 acres of irrigated lucerne—an area which, though small in itself, is a considerable advance over the figures of some years past. Turnips have been successfully grown, and are occasionally put down by zemindars and Court of Wards' Estates with a considerable number of cattle to feed.

"The Department has also experimented with a certain number of new fodders. *Euchlaena mexicana* has been tried, but its outturn is lower than that of irrigated *juar*. Spineless cactus has been tried at Cawnpore; while it makes a fair growth and stands the hot weather, it has so far shown little tendency to spread naturally. *Prosopis juliflora* as a fodder tree has been grown on a small scale and has so far given very promising results.

"Speaking generally, it may be stated that the question of fodder supply in these Provinces is not so pressing as the preservation of breeding grounds and the maintenance of the supply of plough cattle. In normal years the cultivator in his choice of crops is largely guided by the consideration of the

necessity of a supply of fodder for his cattle. The gradual extension of irrigation in Bundelkhand and other dry parts of the Provinces is lessening the danger of a fodder famine in these tracts. In abnormal seasons, *i.e.*, when there is a failure of the rains, the experience of the famine of 1907-08 has shown that the comparative proximity of the forests and improved railway communications, would enable hay to be introduced in quantities which would greatly reduce the cattle mortality.

"The conclusion arrived at after the famine of 1907-8, in which very extensive measures for relieving the fodder famine were taken, was that with all other grass cutting operations suspended, upwards of 80,000 tons of hay could be supplied by the Forest Department. It was noted that, though the less valuable animals were sold or died somewhat prematurely, nowhere were the cultivators seriously embarrassed by the loss of their plough cattle. There are also two private firms in these Provinces which have leased areas of jungle and put down baling presses."

Punjab.—In the Punjab, the Director of Agriculture and Industries, Mr. W. S. Hamilton, I.C.S., has suggested to Deputy Commissioners the consideration of the following steps to help in the provision of fodder and the grazing of cattle :—

"(1) Partition of grazing grounds should be consistently refused under Section 111 of the Land Revenue Act.

(2) *Bhusa*, *jowar* stalks and *bajra* stalks should be stacked in the fields in good years and kept till required in bad years. This is regularly done in parts of Hissar and Gurgaon, and stacks of *bajra* sometimes remain good for 10 years and of *jowar* for 3 or 4 years. There is no reason why the people elsewhere should not be persuaded to this.

(3) Where there is abundant grass, as in Hissar and Gurgaon Hills, it should be made into hay and stacked. The difficulty is to find the labour and the foresight at the time when the grass is ready for cutting, which is also the fever season and the Kharif harvesting time.

(4) Maize stalks should be mixed with green grass or some less dry form of fodder, chaffed, and siloed. The Agricultural Department have made some experimental silos this year. We are not yet prepared to advise; but the Military Dairy Farms regularly make silos of maize stalks.

(5) The canal rates on fodder crops might be reduced. I think an equivalent would have to be levied on some other crop.

(6) The leading landowners and also co-operative societies in non-breeding tracts might be awakened to the economic question whether it would not pay better to grow a little more of the crops which yield fodder than at present, rear up their young stock instead of selling them or underfeeding them as so often happens now, and so avoid the periodical large lump outlay on the purchase of bullocks and of cows. Year by year, as the price of cattle rises, the gap between the return from oil-seeds and cotton which are almost the only non-fodder-producing crops widely grown and the return from fodder crops will lessen. If any Deputy Commissioner can work out for a typical tract in his district the relative profit and loss of (*a*) growing sufficient fodder and rearing young stock, (*b*) putting the land under cotton, etc., instead of fodder or semi-fodder crops, selling all young stock, and buying mature cows and bullocks, it would be of the greatest use.

(7) Possibly co-operative societies might take payments in fodder when it was cheap, stack it and realise a large profit when the next fodder famine came round.

(8) It has been suggested by Mr. de Montmorency and others that on the Chenab Canal the *charagah* might be irrigated from the canal at times when the water was not required for cultivated crops or when, because of a breach, the water would otherwise be run off into escapes. To arrange for this it would be necessary to find blocks of commanded *charagah* large enough to warrant attention, and have water-courses made to them. Probably the Canal Department would give the water free or at a very low charge. This plan might be of use on other canals and might be discussed with the Public Works Department.

(9). *Jowar* and *bajra* might be used much more economically in good years than at present. For example, there would be considerably less waste if the fodder was cut up and not thrown down whole.

"Mr. Stow has divided districts into those which breed and those which import their cattle. Roughly this is a division into districts which are highly cultivated and those which are not so highly cultivated and still have considerable grazing available. The proposals will differ considerably according as the district is a breeding district or a highly cultivated district. In the former, the problem is to maintain sufficient grazing grounds in ordinary times and to arrange for a reserve supply of fodder to meet times of scarcity. In the latter, the aim is to grow enough fodder crops in ordinary times to rear the young stock which are now sold off."

Central Provinces.—Of the position in the Central Provinces, the Director of Agriculture, Mr. C. E. Low, C.I.E., I.C.S., writes :—

" 'The improvement of fodder supply in the dry parts of India' would seem to relate to provinces where the main difficulty in the way of a fodder supply is the dryness of the country : but this is not the case in the Central Provinces ; it is in almost every instance the local agricultural practice that we have to fight against.

"We are not dealing with a tract where good cattle are kept and well fed with farm grown fodder ; and where, if a dry yea threatens the supply of this, there is a fodder famine with loss of cattle.

"The tract is one where cattle keeping is on a very low standard. Stall-feeding is in some places not practised at all : in others only to a small extent ; and with what may be called by-products of agriculture. In Berar and Nimar, where the standard of practice is highest, cattle are fed on pulse, cotton seed and jowar stalks : and this tract is the most liable to loss from famine. Even here, it is rarely if ever, the case, that a drought, even if bad enough to ruin the outturn of juar and cotton seed, reduces

the outturn of juar stalks, etc., to so low a pitch as to threaten famine to the cattle. There is also in these tracts a good deal of grass and grazing. To take the opposite end of the scale, *i.e.*, Chhattisgarh, where there is no stall-feeding, except a little rice straw, and practically no grazing—even a year like 1899-1900 leaves a good deal of rice straw, and the cattle are absolutely better off in a famine year like 1907-08 or 1896-97 than in an ordinary year: there is less for them to do and they graze down the rice crops. What we are proposing to do is, to raise the standard of cattle feeding up to a pitch that will—incidentally—cause much more loss to cattle in a dry year than is the case at present.

"I have very little, therefore, to say about drought-resisting fodders. We have made a few experiments in Australian grasses, such as *Paspalum dilatatum*, which was a failure; it found the hot weather too dry, and the rains too wet. *Chloris virgata* (Rhodes grass), which is found locally, is now being tried, though not especially on account of its drought-resisting qualities. Nothing has been done in the direction of utilising cactus as a fodder.

"The main direction which our efforts have taken has not been that of developing fodders which will stand a dry year, but in inducing cultivators to utilise existing fodders, or provide fresh sources of supply, as a matter of regular agricultural practice, in order to improve the type of cattle. The rice tracts to the east of the Province, especially the rice tract of Chhattisgarh, present a difficult problem. The area is closely though inefficiently cultivated. There are hardly any grazing grounds: and the villagers do not grow fodder crops. The cattle are very small, and incapable of working properly. The grass produced in the surrounding forests and on a few reserved waste lands in the plains is all used for thatching, for which it fetches a higher price than for fodder; it is moreover mostly *sukla* (*Andropogon contortus*) and is unfit for cattle fodder after the spears have grown. Spears can, however, in case of necessity be removed by bush harrowing, or even allowed to drop off, but this leaves a decidedly inferior fodder.

"The forests round the Chhattisgarh plain are used for grazing, mainly by 'ghi' producing castes, cattle breeders and sellers. The cows and working bullocks of the plains are seldom sent there.

"Chhattisgarh is an extreme case: but in most parts of the Central Provinces as has been already explained, very little use is made of the natural grasses for stall-feeding; and very little attempt is made to grow fodder crops.

"The policy pursued is that adopted after a conference of Government officers held in 1909. The terms of reference, so far as they relate to the present question, were as follows:—

(*a*) That steps should be taken to make more use of the existing fuel and fodder reserves by fencing them, and by continuing the experiments in the growth of better fodder grasses.

(I may note that these areas are very small and are a mere drop in the ocean, so far as Chhattisgarh is concerned).

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(*g*) That special concessions in the matter of irrigation rates should be offered for the growth of fodder crops.

(*h*) That it should be considered whether the Forest Department could not assist in the solution of the fodder question.

(1) By carting pressed grass from the remote forests as has been done with profit in the Northern Circle.

(I may note that the Northern Circle lost on this last year).

(2) By lowering the rates for grazing or for grass cutting in the remote forests.

(3) By charging lower rates for the grass extracted before 31st December, a plan which has been tried with success in Wardha.

"I proceed to note briefly what action has been taken on the various recommendations of the conference, and with what results.

"(*a*) The most important experiment undertaken with the fuel and fodder reserves was to cut the *sukla* grass early, before

the spears could form. There is risk of rain and it proved advisable to cut it by machine to save time. A machine cannot be used where the ground is stony, as is the case in many parts of the Central Provinces. A reference to the report on Agricultural Stations for 1910-11 will show the results so far obtained. The areas managed by District Officers gave less successful results. They complain of the risk of damage from rain and of the difficulty experienced in getting cultivators to buy the hay. Little success was obtained by the Department in its attempt to grow better quality grasses on these areas.

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"(*g*) Nothing has yet been done by way of getting rates reduced. Experiments, however, in the growth of irrigated fodder have been carried on in the neighbourhood of Nagpur and in Chhattisgarh, *vide* report on Agricultural Stations in the Central Provinces for 1910-11.

Lack of staff and the difficulty in obtaining clover seed have hitherto prevented this experiment from being pushed: but it is undoubtedly one of the most promising directions in which fodder improvement can be attempted.

"(*h*) The work of the Forest Department was not carried on in connection with this department; from information contained in the last annual report, it would appear that the policy of 'cheap grass and dear grazing' has not hitherto met with much success. When stall-feeding is valued so little, it is clear that some time will elapse before cultivators will trouble to cart grass for their cattle from long distances.

I am asking the Forest Department to inform the Deputy Directors of any future attempts they may make: that the latter may inform them of the most likely areas, and enlist the help of the Agricultural Associations.

"Besides the above lines of effort, the Department have investigated the yield of local grasses; and the feeding value of these and of other fodders locally available. Ensilage is also regularly fed to cattle on the Telinkheri and Powarkhera breeding farms; but its use has not hitherto been demonstrated."

Madras.—In Madras, the work done has been thus summarised by the Officiating Director of Agriculture, Mr. G. A. D. Stuart, I.C.S. :—

"The importance of the question of fodder supply has long been recognised by the Madras Agricultural Department, but so far it has not been possible to find time to attack the problem seriously. The first essential is a systematic botanic survey of the fodder grasses and plants of the presidency. The local names of fodder grasses vary almost from village to village, and little systematic work can be done until a thorough knowledge of the fodder plants has been obtained.

"An assistant of the Government Botanist made a rough survey of the Districts of Guntur, Krishna and Godaveri in 1907 and his report contains much valuable information on the fodder grasses, and on the customs of the cattle owners and breeders in respect to the grazing and feeding of cattle. A similar report on a portion of the Coimbatore District was published in Bulletin No. 27 of the Department of Agriculture, Madras. These reports show that the making of hay, the cultivation of grasses for pasture, the preservation of natural pastures for grazing and hay-making at particular seasons, and the sending of herds of cattle for long distances to more suitable grazing at certain seasons, are all practised in different districts. When the whole Presidency has been surveyed in detail on these points it may be possible to devise plans on which the practice of more backward districts may be levelled up to those of the most progressive. In fact, the same work may be done for the practices of cattle feeding and grazing as is now being done for the cultivation practices of particular crops.

"The most important cultivated fodder crop is sorghum. In some districts this is regularly grown for fodder, while in other districts the practice is unknown. Experiments have been made at the various Government Agricultural Stations to ascertain the best seed rate, the best period for cutting, and the variety most suitable for each district. It is expected that it will be possible to show ryots that this crop can be profitably

grown for fodder in many districts where the practice is at present unknown.

"A beginning has been made in collecting local grasses and testing them pure or mixed for pasture. Grasses from other districts and exotic grasses have also been tried, but generally with poor success. As already stated, this problem needs to be attacked in a systematic manner after a thorough Botanical survey of the fodder plants has been carried out."

Bombay.—Mr. T. F. Main, B.SC., Deputy Director of Agriculture, has submitted an interesting note on the steps taken in that Presidency to investigate what can be done to meet the fodder difficulty in years of scarcity.

"(1) Experiments were commenced in 1908-09 to ascertain how far the surplus supplies of fodder in good seasons could be preserved to meet requirements of bad seasons.

"(2) Enquiries have been begun in connection with the problem of baling fodder in localities which normally produce large surpluses and transporting the same to localities chronically short of fodder.

"(3) A cattle farm has recently been opened of which one of the chief objects is the fodder question.

"With regard to storage experiments, these were undertaken at 3 centres, *viz.* :—

Nadiad—North Guzerat;
Surat—South Guzerat;
Dharwar—Southern Maratha Country.

"At Nadiad in 1909-10 three rectangular stacks each containing roughly 30,000 lbs of excellent *Sundhia* fodder were erected on wooden platforms measuring 21 feet by 11 feet, supported on brick pillars 2 feet high and the covering consisted of *bajri* straw.

"These stacks stood through the monsoon (28" of rainfall) of 1910 and one of them was opened in June 1911. The fodder was found to be good, though two layers on the top had been damaged and 4" at the bottom was discoloured. 21,880 lbs.

sold at Rs. 6-8-0 per 300 lbs. and the following statement compares the purchase and sale values of the fodder :—

30,240 lbs. at Rs. 2-11-0 per 300 lbs. purchased from December 1909 to March 1910	Rs. 271 0 0	21,880 lbs. sold @ Rs. 6-8-0 per 300 lbs. in June 1911 ...	Rs. 474 8 0
Cost of stack platform	,, 35 4 3	5,340 lbs. retained ...	,, 115 11 0
Cost of stacking and roofing ...	,, 27 0 0	610 lbs. partly damaged @ Rs. 2 per 300 lbs. ...	,, 4 0 0
Net gain	,, 260 14 9	2,410 lbs. shrinkage, &c.	
	Rs. 594 3 0		Rs. 594 3 0

"Then followed the famine of 1911 and the remaining two stacks which it was intended to keep till 1912 and 1913 respectively were commandeered by the Chharodi Cattle Farm. Meanwhile the prices of fodder had gone up enormously and in August Rs. 12 and in September-October Rs. 18 per 300 lbs. were the market rates. The details of these two stacks were as follows:—

Stack No.	Original quantity put into the stack.	Sent to Chharodi Cattle Farm.	Reserved at Nadiad.	Partially damaged.	Shrinkage, &c.	REMARKS.
	lbs.	lbs.	lbs.	lbs.	lbs.	
II	30,772	24,701	1,306	1,236	3,529	The fodder obtained was good, but the upper three layers and some portion on the western side were damaged.
III	30,465	21,072	4,987	?	4,396	This stack was situated on the western side of the other two stacks and hence the fodder on its western side was much damaged as well as three layers on the top. The inside fodder was good.

"During 1910-11 three more stacks were put up. On this occasion they were made round, and altogether 69,672 lbs.

of fodder was stored. Different methods of building were tested as follows :—

I. The bottom consisted merely of big earthen clods while the roof was made of grass bundles.

II. The bottom consisted of a raised earthen platform and loose grass was used for the roof.

III. The bottom consisted of a wooden platform supported on brick pillars and the roof consisted of grass thatching in a frame of bamboo.

"The contents of these three stacks had to be removed to meet famine emergencies before they stood through a monsoon, but the following observations were made :—

(1) White ants did great damage to the bottom layers of stacks I and II, while the fodder on the raised wooden platform remained in good condition.

(2) Round stacks are more suitable than rectangular ones. Owing to the interruption in these experiments the following points have not been cleared up as yet :—

(*a*) How long fodder can be kept in good condition when stored as described above.

(*b*) The profit of storing fodder through a period of normal seasons.

Incidentally it may be added that the chief obstacles to storing fodder in North Guzerat are (1) the danger of incendiarism, and (2) the liability of theft.

"At Surat six stacks containing 97,277 lbs. of fodder were put up in 1909-10. Three kinds of covering were tried as follows :—

I. Two stacks thatched with cotton stalks and grass.

II. Two stacks thatched with grass alone.

III. Two stacks thatched with palm leaves.

The bottoms of all stacks consisted of raised earthen platforms.

"One stack out of these three groups was opened in 1911 after standing through the monsoon of 1910, which amounted

to 32·39 inches of rainfall. The percentage of good *karbi* obtained from these stacks was as follows :—

I. 74 per cent. good fodder,
II. 69 per cent. good fodder,
III. 77 per cent. good fodder,

which shows a loss of some 25 per cent. The second stack in group II was opened after the monsoon of 1911,—which amounted to only 17·30 inches of rainfall—when 64 per cent. of good fodder was secured or roughly ⅔rds of the original quantity put into the stack. The cost of constructing these stacks amounted to Rs. 13-8-0 each, while the cost of the fodder in each stack was Rs. 147. In other words, the cost price (including storage) works out at Rs. 6-8-0 per 1,000 lbs. and the sale price would have to be at least Rs. 8-10-0 after the first monsoon, but if the season were similar to the preceding one the price of new *karbi* would only be Rs. 6 per 1,000 lbs.

"Six stacks were put up in 1911 and covered as follows :—

(*i*) Three with corrugated iron sheets supported on wooden standards.

(*ii*) Three with palm leaves supported on bamboo frames.

These have not been opened yet.

"At Dharwar three stacks were put up in 1908-09 and three more were put up in 1909-10. Three types of covering were tried as follows :—

(*a*) mud plastering (a local practice) ;
(*b*) cotton stalks;
(*c*) rice straw.

These stacks were all rectangular in shape. The three stacks put up in 1908-09 were not all of the same dimensions, but the following statement gives the details :—

Type of covering.	Cost of stacking, including covering and repair.	Quantity of fodder stored.	Quantity of good fodder recovered.	Quantity of fodder damaged during storage.	Loss from shrinkage during storage.
	Rs. A. P.	lbs.	lbs.	lbs.	lbs.
Mud plastering ...	23 9 0	23,800	22,143	1,150	507
Cotton stalks ...	24 12 0	41,650	36,095	4,625	930
Rice straw ...	45 10 0	53,500	Not opened.	...	...

"The first of these stacks was opened in August 1911 and the second in December of the same year. The monsoon of 1910 amounted to 22·96 inches of rainfall and that of 1911 to 16·77 inches.

"It was observed that the top portion of the stack covered with cotton stalks was very much spoiled by rain in spite of careful thatching. It will be noticed that less than 7 per cent. of the fodder in the stack covered with mud plastering was unrecovered. If we take Rs. 5 per 1,000 lbs. as the initial cost of *karbi*, then Re. 1 would have to be added to cover the cost of storing and annas 6 to cover the loss due to damage and shrinkage, so that the lowest price at which the fodder could be sold after one monsoon would be Rs. 6-6 per 1,000 lbs. This method of covering has the advantage of costing very little in repairs and of being considerably resistant to fire.

"None of the stacks built in 1909-10 have been opened yet.

"In 1910-11 twelve more stacks were put up, six of which were built round and six rectangular. Corrugated iron has been adopted in covering three of these stacks, but was very costly and will only prove economical provided the same sheets can be used many times over. These twelve stacks still remain intact.

"It may, therefore, be concluded that fairly efficient and cheap methods of storage can be devised, but that in a period of normal seasons the preservation of fodder would result in a money loss to the owner and hence the practice can be recommended only in those tracts where statistics show a sufficiently high percentage of scarcity years. Nevertheless if we take Rs. 2 per 1,000 lbs. *karbi* as the loss involved by storage, we see that for a cost of Rs. 14 a cultivator can store 7,000 lbs. of fodder or sufficient to feed a pair of cattle for six months. If, on the other hand, there is no market demand for surplus fodder at harvest time, it would be economical to carefully store it, as the fodder would most probably command a sale value in the latter part of the fair season.

"The experiments in baling and transporting have not been carried out yet, as Messrs. Marshall Sons & Co., Engineers,

Bombay, are experimenting with a bruizer by means of which it is proposed to prepare the *karbi* for baling.

"It is, however, proposed to mix this bruised *karbi* with various proportions of pulse *bhusa* and then to bale it. This will be done in localities where fodder is normally cheap and the bales will then be transported to localities where fodder always remains at a high price. When this has been done it will be possible to say whether such an arrangement is economical.

"Thirdly, a cattle farm has recently been opened at Tegur in the Dharwar District, one of the objects of which is to cut coarse grass when still in the tender stages and make it into silage and hay and thus to demonstrate how cattle can be maintained in good condition throughout the fair season simply by making the best use of existing resources. There are large tracts where such grass grows profusely, but remains uncut, and is allowed to wither, and it is probable that an enterprising man might make a good thing out of cutting such grass timely and baling it and transporting to localities where fodder is scarce.

"It may be added that for some years past the Department has been making silage at several of the farms and although the people have seen how the cattle relish this succulent fodder, still none have adopted the practice as yet."

(To be continued.)

TIKKA DISEASE AND THE INTRODUCTION OF EXOTIC GROUNDNUTS IN THE BOMBAY PRESIDENCY

BY

E. J. BUTLER, M.B., F.L.S.

Imperial Mycologist.

The decline in the export of groundnut seed from the port of Bombay was the subject of much correspondence between the Bombay Chamber of Commerce and the local Agricultural Department, from 1900 to 1905. The largest export was in 1894-5, when 78,488 tons were shipped. In 1902-3, the amount had fallen to 2,890 tons, and this once important trade had practically ceased to exist. So phenomenal a decrease naturally attracted attention. The Chamber attributed it to a degeneration of the locally-grown seed, and advocated the expediency of importing a new and better quality, such as was reported to be grown in Mozambique and Senegambia.

It may at once be said that no valid evidence was obtained of any degeneration in the quality of the Indian stock. The plant is stated to be a native of Brazil, and to have been introduced into India in comparatively recent times. A number of races developed in India in the course of time, and what is commonly referred to as the "indigenous variety" undoubtedly consists of a mixture of races of unknown, but comparatively modern, origin. Analyses of the seed made in 1838 and 1904 do not show any appreciable difference in the oil content, and no evidence whatever was obtainable to show that the indigenous races had deteriorated as regards quality. On the other hand, there appears to be no doubt that the yield per acre had fallen off considerably. The trade figures showed a rapid decline in the surplus available for export, and a district enquiry indicated that the crop had ceased to be profitable and that the area sown was rapidly contracting.

With reference to the trade suggestion that this was due to "degeneration," the opinion of Sir W. Thiselton-Dyer, Director of the Royal Gardens, Kew, in 1899 (quoted in Watt's "Commercial Products of India," 1908, page 76) is of interest. He wrote: "I may say at once that deterioration of seed is a facile theory, which is continually advanced when the produce of a crop is disappointing. It is one in which I have very little belief. The real explanation of the falling off is to be found usually in the exhaustion of some constituent of the soil." With this opinion Mr. Mollison, with his unrivalled knowledge of Bombay agricultural conditions, was able to agree, except that he believed that other causes were at work than mere exhaustion of the soil. He did not think that any positive deterioration in the seed of the Bombay crop could be proved. In 1902, he stated that the decline was due largely, in his opinion, to diseases affecting the plant, which had become more prevalent in recent years. A succession of unfavourable seasons no doubt helped to increase the unpopularity of the crop, but this reason is insufficient by itself to explain the prolonged period of depression which was experienced not only in Bombay, but in the much larger trade of Madras and Pondicherry.

Attention was therefore directed to the diseases from which groundnut suffers in India, and in 1902 the writer was directed by Mr. Mollison to study the question. It was soon evident that the crop was suffering very severely indeed from a disease, locally known as *tikka,* which was determined to be due to the fungus *Septogloeum Arachidis* Rac.

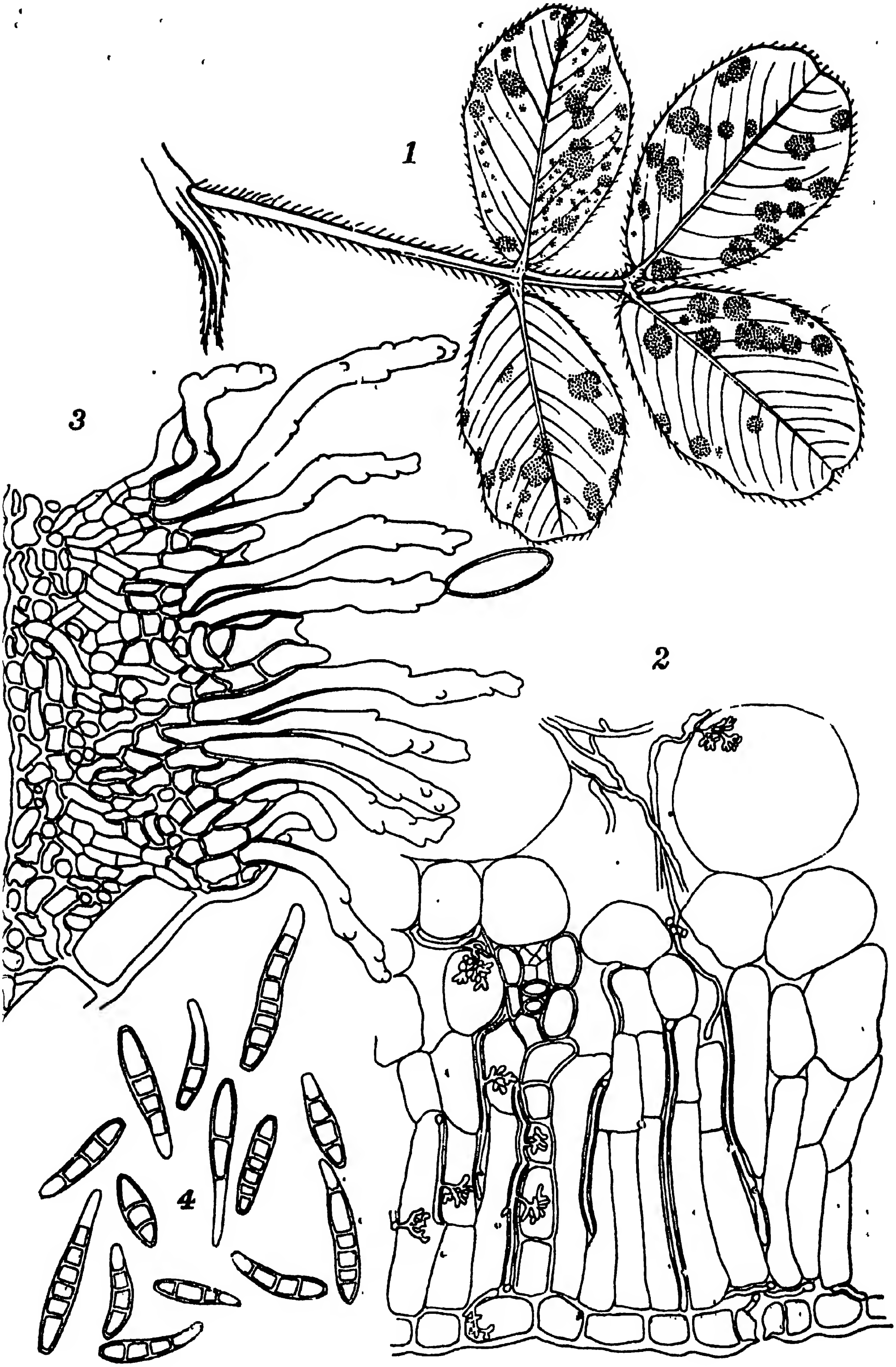
Septogloeum Arachidis was first described in 1898, when it was discovered attacking the immense fields of groundnut grown in the low country in Java. These fields were often, it was said, entirely wiped out by the disease. The published account occupied only about half a page, and no suggestions for remedial measures were given. An equally brief mention of the disease in German East Africa was published in 1904. It has also been recorded from Ceylon, and probably occurs in most parts of Asia and Africa where the crop is grown.

The disease first appears in Bombay, when the plants are from one to two months old. The lower leaves are the first to be attacked; dark spots, surrounded by a bright yellow ring, come out in large numbers on the green leaves; a few also occur on the petioles and stem. The number of spots on a single leaf may be from one to a dozen or more, and their size from one-tenth to one-third of an inch in diameter, the shape being generally round. The remainder of the leaf only slowly loses its green colour, but before this is gone, it falls to the ground. This shedding of the leaves is, indeed, the most striking feature of the disease; it is apparently due to some poisoning action of the parasite, as even leaves with only a single spot, fall prematurely. After the disease has been in progress for a week or two, affected plants can be at once recognised by the litter of fallen leaves round their base.

In the later stages the effect is not unlike that caused in potatoes by the well-known potato-disease. The field. which, earlier in the season, had been densely covered by the green foliage of the crop, shows a mass of fallen withered leaves, from which the bare stalks, with perhaps still a few young leaves at the tip, stand out.

Naturally, when the attack begins early, the plant is unable to mature its nuts. Those that have begun to form as the attack reaches its height, cease development, and at harvest are found shrivelled and loose in the shell. If they have reached a certain stage of maturity before the disease becomes severe, the reduction of the total yield of nuts is less marked, as the loss of leaf occurs too late to check their development. In many cases, however, losses of from one-third to one-half have occurred in infected fields.

The fungus is found in the plant tissues in the neighbourhood of the spots. It consists of slender branching threads, which run chiefly between the leaf cells, and send feeding branches or suckers into them (Plate III Fig. 2). Cells thus infected wither and collapse, and this leads to the appearance of the brown spots. After growth has thus continued within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the leaf for a week or two, the fungus forces its way to the surface to reproduce. The threads collect in masses near the surface of the leaf, and form small cellular cushions of a brown colour just below the epidermis (Plate III Fig. 3). The superficial cells of these cushions grow out into cylindrical protrusions, which by their pressure rupture the epidermis, and appear on the surface where they develop into spores. Hence, at this time, the centre of the spot is occupied by a number of tiny dark-coloured cushions (usually arranged in concentric circles), which have a powdery appearance from the loose mass of spores with which they are covered.

The spores (Plate III Fig. 4) are cast off as soon as ripe, and being very light, are readily blown about by the wind. They germinate rapidly in water or very damp air, usually by putting out a single germ-tube from near one end of the spore. The power of germination is preserved for a considerable time, both in spores that have been dried and in those that have fallen on the soil. Dried spores were found to germinate after six months, while the observations made during the field study of the disease afford strong evidence that infective material persists in the soil from one season to the next. The fungus has not been found, in spite of very careful search, on any other plant than groundnut. It must, therefore, be carried over from year to year either in the seed or in the soil. Experiments in steeping the seed with various fungicides have not proved successful in checking the disease, and when the large numbers of spores shed on the soil, and their capacity to withstand drying, are taken into account, there can be very little room for doubt that the early attacks come from spores which reach the lower leaves from the soil. In those cases where the disease has appeared in localities where the crop was previously unknown (of which several examples have occurred in India and Burma) it is probable that it was introduced with the soil adhering to the shell, and not with the seeds themselves. Subsequent spread is undoubtedly largely effected by the wind. The plots at Kirkee, in 1902, showed this very clearly. The first attack appeared at one corner of a

field, the prevailing wind blowing across the field from this corner. In about three weeks' time, the path of the disease could be traced in a wedge down the line of the wind, right across the field.

Inoculation experiments have been carried out in Java, India, and Ceylon, with harmonising results. From about four days to a week after sowing fresh conidia on the leaves, new spots were formed. The Indian experiments were done at Poona on two plots, separated by a third which was not inoculated. The inoculated plots developed the disease rapidly, and after some weeks were found thoroughly infected, while that between was still quite healthy.

Attempts to check the disease were based on three considerations :—

(1) It might be a seed-borne disease ; (2) it might be possible to control it by spraying ; (3) there might be disease-resisting varieties of groundnut.

If it were conveyed on the seed, and there were no other means by which the fungus could tide over the period between successive crops, seed disinfection should be efficacious. Several experiments were carried out at Kirkee, copper sulphate being the disinfectant used. As already stated, they yielded no results. The disease had been present on the farm for some years, and no doubt all the soil was infected. On the other hand, groundnuts introduced from Poona to Pusa, where the crop was previously unknown, and treated either with ½ per cent. copper sulphate for half an hour or ¼ per cent. formalin for four hours, remained free from *tikka* disease. Hence, when the crop is introduced into new localities, care should be taken either to obtain seed from some place where *tikka* does not occur, or else to disinfect the seed by steeping in some fungicide, preferably before despatch from the place of origin. As little soil as possible should be left adhering to the nuts, as it is in this soil that the fungus is likely to be conveyed in the form of spores.

Spraying was tried at Kirkee in 1903 and 1904, Bordeaux mixture being employed at the rate of 50 gals. to the acre and two

sprayings being given at an interval of about three weeks. The mixture was made with 6 lbs. copper sulphate and 4 lbs. lime to 50 gals. water. The results were unsatisfactory. The spores are formed on the under surface of the leaves and the crop covers the ground so densely that it is practically impossible to reach them with the spray. Spraying was, therefore, abandoned, as it did not appear probable that any efficacious method could be devised.

While these experiments were in progress, exotic varieties were introduced, in the hope of obtaining kinds which would yield well, even in presence of the disease. The following description of the work of the Bombay Department of Agriculture in this direction has been condensed from a note kindly supplied by Messrs. Kelkar, Officiating Deputy Director of Agriculture, and Gokhle, Superintendent, Agricultural College Station, Poona.

The first importation was in 1901, when 1 ton of Pondicherry* seed was obtained from Madras and distributed in Satara and Poona Districts. The same year small quantities of "Spanish peanut" and "Virginia" varieties were obtained from America and of "Small" and "Large" Japanese from Japan. These were grown on the Kirkee and Surat farms.

In 1902, seed of all these kinds was distributed in the same districts as the previous year, and was also sown at Kirkee, Manjri, and Surat farms. *Tikka* disease appeared in August, the variety first attacked at Kirkee being the Spanish peanut, and at Manjri the small Japanese. At Surat there was no *tikka*, though a leaf spot caused by *Cercospora personata* (which is frequently confused with *tikka* but does little damage), was prevalent. It was in this year that the value of varieties which mature their nuts early was first observed. The small Japanese had its nuts so far developed at the end of September, when the disease at Kirkee and Manjri was spreading rapidly, that comparatively little injury was caused. The Pondicherry was little

* The Pondicherry variety is of Mozambique origin, introduced into Madras, *viâ* Mauritius, hence it is sometimes called "Mozambique" or "Mauritius" in India.

inferior, though it takes longer to ripen than the last. The Spanish peanut, on the other hand, though an early variety, commences to form its nuts later than the last two, and was caught by the disease in a stage in which considerable damage was effected. The Virginia, large Japanese and indigenous varieties are late maturing, the last being particularly late, and are hence much injured when attacked before October. As regards relative susceptibility to attack, no very definite differences were observed.

In 1904 and 1905, about 1,000 lbs. of seed of these varieties were supplied to orders received, and further tests were carried out on the Government farms.

Encouraged by the continued success of these efforts, 3 tons of fresh Pondicherry seed were obtained in 1906, and distributed in Satara, Nasik, and Poona Districts.

In 1907, 5 tons each of large Japanese, Spanish peanut, and Pondicherry, were imported, and the area of distribution extended to Ahmednagar and Sholapur. The Government farms also continued to grow and distribute exotics, Dharwar, Dhulia, and Dohad taking up the crop in 1905, 1906, and 1907, respectively. No further distribution of the Virginia seed seems to have occurred, but between 1909 and 1912, seed of Pondicherry, Spanish peanut, Large Japanese, and Small Japanese, to the amount of over 75,000 lbs., was distributed, the farm produce being supplemented by quantities purchased from selected cultivators.

As a result of this work, the exotic varieties have taken a permanent hold in almost all the Talukas of the Satara District (which contains much the largest area under groundnuts in the Presidency) and also in the Southern Mahratta States, so much so as almost to have superseded the local varieties. They are also widely spread in Nasik, Ahmednagar, Khandesh and Belgaum, but the total area under the crop in these districts is not large. In Poona District the indigenous still holds its own, as it is preferred to the exotics in the local market, being almost entirely grown for eating raw. Irrigation facilities are also better in

this district, and the need for early varieties not so much felt. But in the districts in which the crop is grown for export, the new varieties have driven out the old, one of the reasons given being, that though similarly affected by *tikka*, the damage done is much less, as the nuts are formed by the time the crop is attacked (Kelkar, "Groundnuts in the Deccan," Department of Agriculture, Bombay, Bull. No. 41, page 16, 1911).

It was remarked in 1912 that no specimens of *tikka* disease from Bombay had been received in the Mycological Laboratory at Pusa for some years. The Mycological Staff of the Bombay Department also reported that they had not observed any true *tikka* in recent years. The writer accordingly visited Bombay Presidency in September—October, 1912, and failed to find a single case of *Septogloeum Arachidis*, except in a small patch at Manjri farm. The localities visited were Poona, Dharwar, Dhulia, Savda, Surat and Dohad; taken in conjunction with the failure of the local Mycological staff to find any specimens of the disease in the two or three previous years, it is evident that *tikka* has practically disappeared from Bombay Presidency.

Coincident with the introduction of the exotics and the disappearance of *tikka*, the exports of groundnuts from Bombay began to rise. As already stated they were only 2,890 tons in 1902-3. In 1906-7 they were 6,527 tons, in 1909-10, 23,934 tons, and in 1912-13, 48,801 tons. The recovery is, therefore, almost as phenomenal as the decline previous to 1902.

How far is the Bombay Department of Agriculture entitled to claim the credit for this remarkable result? I think entirely. Explain it how we may, I think there is no reasonable room for doubt, that the increasing popularity of the crop is consequent on the introduction of the exotic varieties, which was pushed with great vigour as soon as it became evident that they yielded satisfactorily.

The explanation of the result is more difficult. The previous decline may have been due to "deterioration" of the seed, as the Bombay Chamber of Commerce suggested; to exhaustion

of the soil owing to want of proper manuring (or rotation), as Sir W. Thiselton-Dyer thought likely; to a succession of bad seasons, combined with deterioration, as has been advanced by some members of the Bombay Department itself; to low prices; or finally, to the increasing prevalence of disease, as stated by Mr. Mollison.

There has been no such change in the manurial or cultivation practices of the cultivators in the Deccan as to enable us to accept Sir W. Thiselton-Dyer's explanation. Though, no doubt, the crop suffers in places, as most Indian crops do, from insufficient manuring and bad cultivation, it is quite impossible to believe that this can have been responsible for the very rapid decline in the crop, followed, as it was, by an almost equally rapid rise. With Sir W. Thiselton-Dyer's view that there was no seed "deterioration," we may perhaps agree, though with caution. There are probably few well-authenticated cases of deterioration in crops grown from seed, though many, where propagation is by vegetative parts, such as cuttings, tubers and the like. Where deterioration of seed crops has occurred, it is probably due, in most cases, to the growth of mixed strains, where the swamping effect of inferior races, gradually replacing the better kinds, leads to a progressive falling off in quality or yield. It is quite possible that this actually happened (as regards yield) in the "indigenous" variety of groundnuts, and if it has happened once, it will happen again, unless measures to check it are taken.* The chief of these measures is the continued supply of pure races of established value from the Government farms. It is unnecessary, however, to go into this matter in detail, as it has been more than

* There is some evidence that the crop is deteriorating in Madras. The Madras Chamber of Commerce reported, in 1912, that the output per acre is seriously diminishing year by year, where the crop has been long established; that the size of the kernels is also deteriorating; and that it is feared that the trade will suffer an eclipse, such as was experienced some twenty years ago, when the export of groundnut dropped suddenly and finally almost died out, only to be revived when fresh Mozambique seed was introduced. The Madras Department of Agriculture in reply attributed this decline entirely to faulty cultivation, but it is clear that the matter is one which requires careful study.

once discussed in the pages of this Journal (see, for instance, the paper by A. and G. L. C. Howard, Vol. VII, page 167, 1912).

It is quite impossible to accept the explanation that bad seasons were the cause of the failure of the crop. The decline and recovery were too progressive, and the area involved (comprising as it did considerable portions of Madras and Bombay) too large, to permit us to agree with this view.

Prices alone will not serve to explain the fall in exports and subsequent recovery. It is true that there has been a marked increase in prices of Indian oil seeds during the last ten years, but the increase has been relatively greater in certain other seeds, such as linseed, rape and sesamum, than in groundnut, while the area under these crops has not increased to anything like the same proportionate extent.

There remains the explanation that the incidence of disease in the crop is at the bottom of the matter. The difficulties in accepting this explanation are considerable. On the one hand, is the observation that the imported varieties were attacked as readily as the indigenous, when first grown; on the other, that the indigenous is now as free from disease, near Poona, as the exotics. But it is impossible to escape from the fact that *tikka* was at its height when the exports from Bombay were at their lowest figure, and that the recovery has coincided with the disappearance of the disease. No simple explanation can be proposed, but we are gradually beginning to realise that a field crop is not in any sense a unit; that it consists of a complex of races responding differently to the environment (in which must be included disease) and that the composition of the complex may be profoundly modified, especially if crossing occurs, by the introduction of new kinds, or by the growth of a variety in a new environment; and we have no means of knowing whether the disease may not, in itself, have brought about the establishment of a crop resistant to its effects, by killing out those constituents of the varietal mixture which were most susceptible to its attack.

If this be the correct explanation, the case is one of considerable interest, as being one of the few recorded in which a serious crop disease has been checked by the introduction and acclimatisation of exotic varieties.

Description of Plate III.

Fig. 1. Leaf of groundnut attacked by *Septogloeum Arachidis* Rac., to show the distribution of the spots.

" 2. Section of the leaf to show the filaments of the fungus passing between the leaf cells and sending branched suckers into the cell cavities. × 480.

" 3. Spore-bearing cushion, from a spot on the under surface of the leaf, showing the branches on which spores are borne, projecting into the air. × 950.

" 4. A group of spores from a cushion such as that figured in Fig. 3. × 480.

A SCHOOL GARDEN IN THE MAKING, ITS OBJECTS AND USES

LT.-COL. J. J. CRONIN, I.A.

Deputy Commissioner, Kyaukse.

REALISING the truth of the saying that the greatest source of wealth that any nation has at its disposal lies in its children and that the education hitherto afforded in the elementary schools has not been of a sufficiently practical nature, the more advanced countries have, for some little time past, devoted themselves to the introduction of schools which, in the words of a late President of the United States, shall teach the children as much outdoors as indoors and so prepare them for the needs of country life and not as at present mainly for life in a town.

Burma is at present far behind other countries even in the East where school gardens have been in existence for some years; for instance, Ceylon with over 200, Java, and the Philippines. In America and England they are found scattered all over the country.

It is remarkable what hazy ideas exist as to the object of school gardens. A good many people look upon school gardening as having for its object the cultivation of a few vegetables and flowers and nothing more. Even so, it would be of some value in teaching the boys and girls to be neat and methodical, useful and resourceful. The possibilities and usefulness of a school garden, however, are far greater than this; in fact it is now held that the development of the school garden is the most important advance in modern education.

In a country almost wholly agricultural such as is Burma where seventy-five per cent. of the population are agriculturalists, it is one of the great needs of the country side that the children should be taught not merely the ordinary indoor curriculum of the elementary school but that advantage should be taken of the child's longing for the open air and for playing at work, to develop its powers of observation and the acquiring of practical information from the material provided in the school garden for arithmetic, mensuration, drawing, composition, and nature study, in a living, actual form.

Of the few hobbies to be found among the people of Burma the commonest is the possession in almost every Burman family of a few pots of flowers or ornamental shrubs, if only a few straggling roses or anæmic crotons.

Here is an opportunity where advantage can be taken of this one well recognised hobby of the people to develop it along practical lines. The school garden teaches the children to become interested in plant life, to use their hands while realising that it is not undignified to work, and to take a new interest in their surroundings. It also enables them to add fresh and often new vegetables to the home supply or to obtain a little money from their sale, a welcome addition to the family income, as a result of their healthy outdoor work in the garden. In many schools in other countries it has been found that the school garden course has developed the children physically, mentally, and morally, turning out healthy, bright, and quickwitted children, who are able to pass their examinations in an appreciable fraction of the time occupied by the children of the indoor schools.

The training that a boy has received in the ordinary village school garden, even supposing that he is not going to earn his living as an agriculturalist, will have developed habits of industry, economy, thrift, method, and resource, and will have sharpened his powers of observation and taught him both the rights of property and the rights of others.

Some of the more important uses of school gardens are, to serve as object lessons in the cultivation of useful plants, as

centres for the distribution of useful seeds or improved varieties of common seeds together with information about them, to induce the cultivator to take up the cultivation of new or improved products, to encourage children to establish gardens at their homes, and to induce competition between the school children and between adjoining schools.

Up to last year no attempt had been made in the Kyaukse District to start either school or home gardens. In the cold weather of 1912 a beginning was made by the Deputy Commissioner in giving out oblong boxes, some with flowers and some with vegetable seeds, to the children who took an interest in plants at the vernacular school at Minzu. These boxes were taken home, prizes being awarded later for the best home (box) gardens. Later the first school garden in the District was started, at Myittha, at Ma Pu's vernacular school, where all the soil had to be brought in; the beds were then all prepared by the pupils, flower and vegetable seeds being issued, and instruction given. At a small horticultural show held at the Myittha Pagoda festival last February three school gardens competed.

It was not until this year that a grant was given by the Educational Department for the opening of school gardens in the District. Now ten school gardens, for the laying out of which great credit is due to Mg. Ba Kin, Deputy Inspector of Schools, are in process of formation, of which the type may be taken as that at Indaing, and which illustrates the progress being made up to date in the Kyaukse District. This school, one of the old Rs. 500 Government Schools, is the best in the District.

It was burnt down in a fire which destroyed the village in March last. A new building has since been erected. The school garden, of an area of a quarter of an acre, has been laid out facing the school building, and has been divided into (1) individual plots, each 8 feet by 4, four feet being found to be a width a child can stretch over from either side without having to walk on the beds, (2) collective plots for cultivation by parties of children, and (3) demonstration plots for showing the villagers some new crop, in this case planted with Madras castor seed.

In addition a weed plot has been formed to enable the children to distinguish between weeds, useful, troublesome, or poisonous, and plants which they have sown. Compost and weed pits have been dug and sheltered seed beds formed. The paths have all been laid out and sanded by the children themselves, while they have also laid down a grass lawn in front of the school and planted out a number of flowering and ornamental plants and shrubs. Only useful plants are being put down such as will yield a quick return. These are planted on the edges of the garden and consist of the *talôkmagyibin,* the papaya of two varieties, and plantains as a wind screen. Nearer the centre of the garden flowering shrubs are planted, while nearer the pathways are planted flowering plants the produce of which is in demand in the bazaar, *e.g.*, tuberoses, sunflowers, etc., while on the fences creepers are trailed, Indian coral, Rangoon creeper, Morning glory, etc., shade for the main building is provided by gold mohur trees from the Government nursery. A few easily grown flower seeds such as balsams and zinnias have been issued to the children who have been instructed in their planting. All seeds are being ordered at present in penny packets from Ryder and Sons, St. Albans, England.

For one anna it is now possible to start a garden, which will repay its cost many hundred times, owing to the cheapness with which seeds of excellent varieties are obtainable.

A succession of the most favoured and easily marketable vegetables (European and native) are being grown, such as—radishes, lettuce, knol khol, cabbage, beans, celery, egg plant, and okras.

In the demonstration plots it is hoped to plant new varieties of chillies, onions, okra, brinjals, water melon, cotton, etc. Meanwhile, the children are being instructed in laying out plots, calculating the amount of seed required to a plot, in recognising the various common weeds, the different useful grasses, and the useful or destructive insects and birds of the garden. Later, they will be instructed in the necessity for a rotation of crops if the best results are to be obtained, deep vertical rooting

crops of the vegetable garden being followed by pod bearers, and these by leaf crops, radishes being followed by peas and beans, and these by cabbages or spinach, in order to enable them to understand that different classes of plants require and extract from the soil different food constituents.

The advantage of intercropping, *e.g.*, the planting of radishes and spinach between rows of peas, and of lettuce between rows of dwarf beans will be explained. In addition the elder boys are being instructed in the kinds of cattle disease common in the neighbourhood, their symptoms and simple methods of treatment and prevention.

Competitions are being arranged for with other schools, while it is hoped that the school will exhibit at the next vegetable exhibition at Myittha. Lastly, home gardens are being encouraged, boxes supplied and seed issued to boys and girls of the school to take home, prizes being offered for the best exhibits. A plan to scale has been made of the garden and is hung up in the school. Each pupil allotted to a plot is required to keep a note book. The northern half of the compound has been made into a football ground and fenced off, a football being provided, while swings and skipping ropes have been provided for the girls.

The value of this school is already shown by the interest it has aroused among the villagers and the willing co-operation which has been forthcoming.

In this District, a great improvement is already noticeable in the condition of many of the house sites in villages where school gardens have been introduced. Rank vegetation and general untidiness have given place to neat little plots of flowers and vegetables. A further step, with promise of far reaching results, has lately been taken in inducing some of the managers of Buddhist monastic schools to start school gardens in the monastic compounds.

Handicraft is being encouraged, all boxes, tool handles, pegs, labels, mallets, cultivating sticks, and measuring rods used in the gardens being made by the pupils.

It is hoped that the Director of Agriculture will see his way to allowing travelling instructors from the Department to be detailed to visit the various schools, especially before the cold weather commences.

In a few cases it has been found that the parents of children attending the school look on manual labour with contempt as beneath the dignity of themselves or their children. They should know that it is just those countries where manual labour has never been looked on as a bar to advancement which are the most advanced and wealthiest. Sooner or later these children will plead to be allowed to join. In a recent instance, the children of a well-to-do Burman resident who at first were not allowed to take up school gardening, are now amongst the keenest in their class and have already taken several prizes.

> There is not a pair of legs so thin,
> There is not a head so thick,
> There is not a hand so weak and white,
> Nor yet a heart so sick,
> But it can find some needful job that is
> Crying, to be done.
> For the glory of the garden glorifieth every one.
>
> Rudyard Kipling, *The Glory of the Garden.*

PRACTICE WITH SCIENCE

A. C. DOBBS,

Assistant to the Agricultural Adviser to the Government of India.

In the last number of this Journal, there appeared, under the title of 'Bergson and Botany,' a criticism of certain passages of my review, in a previous number, of Mr. Balls' book "The Cotton Plant in Egypt."

I say advisedly "of certain passages," for with the views expressed by 'Ulula' I am so far in agreement that, although, having gone so far some further explanation on my part may seem advisable, all that seems strictly necessary is to ask the Editor for space to enable me to point out where 'Ulula' has misread the meaning of the text, and where the letter does in fact convey a wider meaning than was intended.

And—before going further—this necessity affords me a welcome opportunity for tendering to Mr. Balls an apology for having allowed a perhaps pardonable irritation at the manner of his book to exclude all consideration of the large amount of other work he has done. The book under review was a collection of separate items of research, and its chief fault was, as has been said by a well-known authority, that it was published in book form at all. It is no way representative of Mr. Balls' work as a whole, in view of the extent and variety of which the last sentence of my review might justly be stimatised as patronising.

But to turn, after so much of personal explanation, to the question of wider interest which was the subject of 'Ulula's' protest,—the review under discussion was itself partly a protest

against the apparently pointless analysis, by statistical methods involving a very large amount of routine work, of the intermediate factors concerned in the relations between phenomena the apparent mutual significance of which could easily be grasped by the intuition that comes from practical experience.

It was suggested that when the economic object of such analyses is not clear, they should be left to the pure scientist, who, untrammelled by economic requirements, can choose approximately ideal conditions to work in and material to illustrate any principles on which his genius can throw light.

There was no intention of suggesting that such quantitative investigations as might assist materially towards the attainment of an object in either case could be stigmatised as 'sordid,' but merely that a *large* amount of work should not be done without some definite object or ideal in view, or published without that object being made apparent. And, though the passage quoted by 'Ulula' in this connection certainly confused the two issues, the words 'such work,'—on which it was suggested that the expenditure of time by an official was a mistake—were intended to relate primarily to the apparent significance, and not solely to the quantitative nature, of the work in question.

A distinction was indeed implied, between 'pure' and 'economic' science, that is not inconsistent with that drawn by 'Ulula'; but it was not intended that the distinction should be pedantic, or that observations that are incidental to an investigation of one kind but which may appear to be of possible importance to one of another kind, should not be published in scientific papers where they will attract the attention of other investigators; though such observations should perhaps not as a rule be made the *subject* of independent investigations.

And in pointing out that the use of the word 'pure' as applied to science, was a special one, and that the one kind of science need be no less pure—in the ordinary sense of 'unmixed'—than the other, the attachment to the word 'pure' of any moral significance in this connection was surely deprecated rather than suggested.

The contention then that it is wished to advance is that an 'economic' scientist should not spend a large amount of time on investigations of no apparent importance ('immediate' was perhaps not quite the right word) to the economic interest in which he is employed, and that if such investigations are obviously required, a 'pure' scientist should be selected for the work.

It may be—in some cases it certainly has been—the case that Governments have, if perhaps by chance, secured the services of 'pure' scientists where 'pure' scientific work was required, and have passively acquiesced in, if not actively encouraged, the exercise by them of untrammelled genius in investigation. Indeed we number among ourselves such men,—whose exclusion on account of their anomalous position as regards agriculture in particular, from a department called for general convenience agricultural, would be a loss to the department. But when it comes to the publication of results, is it not desirable, if only in the interests of administrative simplicity, that the economic significance, immediate or otherwise, of the work published, should be not only demonstrable, but at least indicated in terms which the public that pays for the investigations can understand?

There is nothing wrong in the tactful, artistic advertisement of a good thing, and though it is unfortunately the case that a love of abstract truth is frequently associated with a hypersensitiveness that shuns publicity, the public is yet perhaps not in practice very far wrong when it acts as if it believed that the man who cannot or will not explain himself has probably found little or nothing worth explaining. It is a rough and ready criterion; but if an idea that is worth elaborating to the point of demonstration does not always stimulate an enthusiasm sufficient to overcome personal idiosyncrasies and force the idea to the front, it is at any rate in the interests of the public that it should do so.

Frankly, the world has no use for the monk whose discoveries have to be rediscovered.

But the point having now, with 'Ulula's' help, been made clear, that the review under discussion was not a disingenuous

attempt to deprecate the official recognition of 'pure,' if purposeful, research ; it remains to insist that it was genuinely intended to be mainly a defence of the 'economic' scientist—against, for instance, such an indictment as that brought against him by Mr. Balfour in the passage quoted by 'Ulula :'— "*The man of science working consciously towards that end*" (the application of his doctrines to the practical needs of mankind) "*was only half a man of science, and was not likely to do his scientific work nearly as well as if he were simply and solely occupied in advancing that branch of knowledge with which he was connected.*

It might of course be said that in attempting to discourage, by dubbing as unscientific, the selection, for purposes of climbing to the light, of those branches of the tree of knowledge which bear fruiting spurs instead of an impenetrable mass of twigs, Mr. Balfour is merely wasting his time : and in so far as the sentence quoted is a definition of the commonly understood meaning of the term 'pure science,'—while it may be observed that it differs radically from that given by 'Ulula,'—no exception need be taken to it.

But in so far as he implies that an economic scientist cannot do his work well, it is necessary to enter an emphatic protest against the dictum even of so justly renowned a philosopher as Mr. Balfour. The words come ill indeed from one who has shown the world by his own example that the subservience to the practical needs of mankind of the spirit of the quest of high ideals can, on occasion, raise even what is commonly so sordid an occupation as politics to a plane on which a philosopher is not out of place.

It is, in fact, just that commonly understood distinction between pure and economic science that is wrong.

Mr. Balfour, in effect, deprecates specialisation on economic lines by saying that the accumulation of knowledge for its own sake is a purer and therefore better thing than the study of the practical needs of mankind.

Is it?

Is it not, as a matter of fact, one of the most gratifying results of recent explorations that that 'purest' of researches, the

search for the poles, having attained its object, the lodestone that drew explorers from more useful paths has now lost its power?

Has not Mr. Balfour been beguiled into a false position by the fact that systematised reason—the scientific method, has been till recently a weapon in the hands of the leisured few, and was therefore used only on the most carefully selected of first principles of the widest application?

Now that a steadily growing percentage of mankind is being trained in the use of that instrument, is it not desirable—essential, that the greater number should also be trained to turn it to account on lines conditioned by economic necessities, leaving to those whose equipment renders them independent of adventitious aids the pursuit of those trails which though sensibly straighter, yet pass apparently through inhospitable wastes?

A young scientist, newly trained, and turned adrift on a world of which he has been taught to ignore the outstanding features, may well be compared to one of the followers of that famous Captain of original research who—

> 'had bought a large map representing the sea,
> Without the least vestige of land:
> And the crew were much pleased when they found it to be
> A map they could all understand.
> "What's the good of Mercator's North Poles and Equators
> Tropics, Zones, and Meridian Lines?"
> So the Bellman would cry: and the crew would reply
> "They are merely conventional signs."
> "Other maps are such shapes, with their islands and capes!
> But we've got our brave Captain to thank"
> (So the crew would protest) "that he's bought us the best—
> A perfect and absolute blank."'

And would he not probably find, like the man who—

> 'came as a Baker but owned when too late
> * * * *
> He could only bake Bridecake, for which I may state
> No materials were to be had'

that his quest ended in a 'Boojum.'

The amateur is not always a 'Baker,' but at least let us who are not amateurs, dealing with the world as we find it, content ourselves with the assurance that there is, in the most prosaic of occupations, an opportunity for the cultivation of truth and imagination, and the pursuit of high and independent ideals—provided only that we can emancipate ourselves from the sordid slavery of our conventions, not mistaking the means for the end, nor sacrificing the choicest spiritual gifts to the Moloch of the latest scientific nostrum.

'Bergson,' as one of his critics has said in a happy phrase, 'is a poet.' But he represents, vaguely though it be, a very real and practical idea—the reaction of philosophic thought from the conscious effort necessary to support the weight of the ever-growing body of scientific knowledge.

He offers us a loophole for escape in the suggestion that the thousands of generations that have gone to the development of our individual human intellects are as nothing to the millions that have gone to develop our common human instincts, and that the latter are, at this stage, perhaps a better stock from which to encourage further development than the former.

We cannot all be 'calculating boys,' but we can all acquire and develop the habit of looking beneath the surface of things, of remembering the common substratum of sequence, underlying many different events as one melody may run through many keys and phrases, long after we have forgotten the events themselves —events, may be, that are better forgotten than recorded. We can all encourage that 'consciousness of the living flow and interplay of things,' which does not suffer from being incommunicable if only it be not uncommon—that intelligence which is independent of all concrete knowledge and which enables one man to sense, in art or music, science or social intercourse, what another has to learn.

Our reason differentiates us from the ant; but it is because our reason is imperfect,—because we still have consciously to *think*—that the clumsy paraphernalia of science are essential to

the attainment of knowledge. *Bergson bids us remember that they are* paraphernalia—supports to help us to walk erect,—and suggests, not that we should throw them away, but that we should essay, when possible, to walk without their aid.

And so encouraged, those of us who feel the weight of our equipment most, may well elect to walk where we need carry least, devoting our greater freedom to the task demanded of us by India's insistent poverty—of ministering to the *practical needs of mankind.*

A TRIAL OF ORANGE STOCKS AT PESHAWAR

BY

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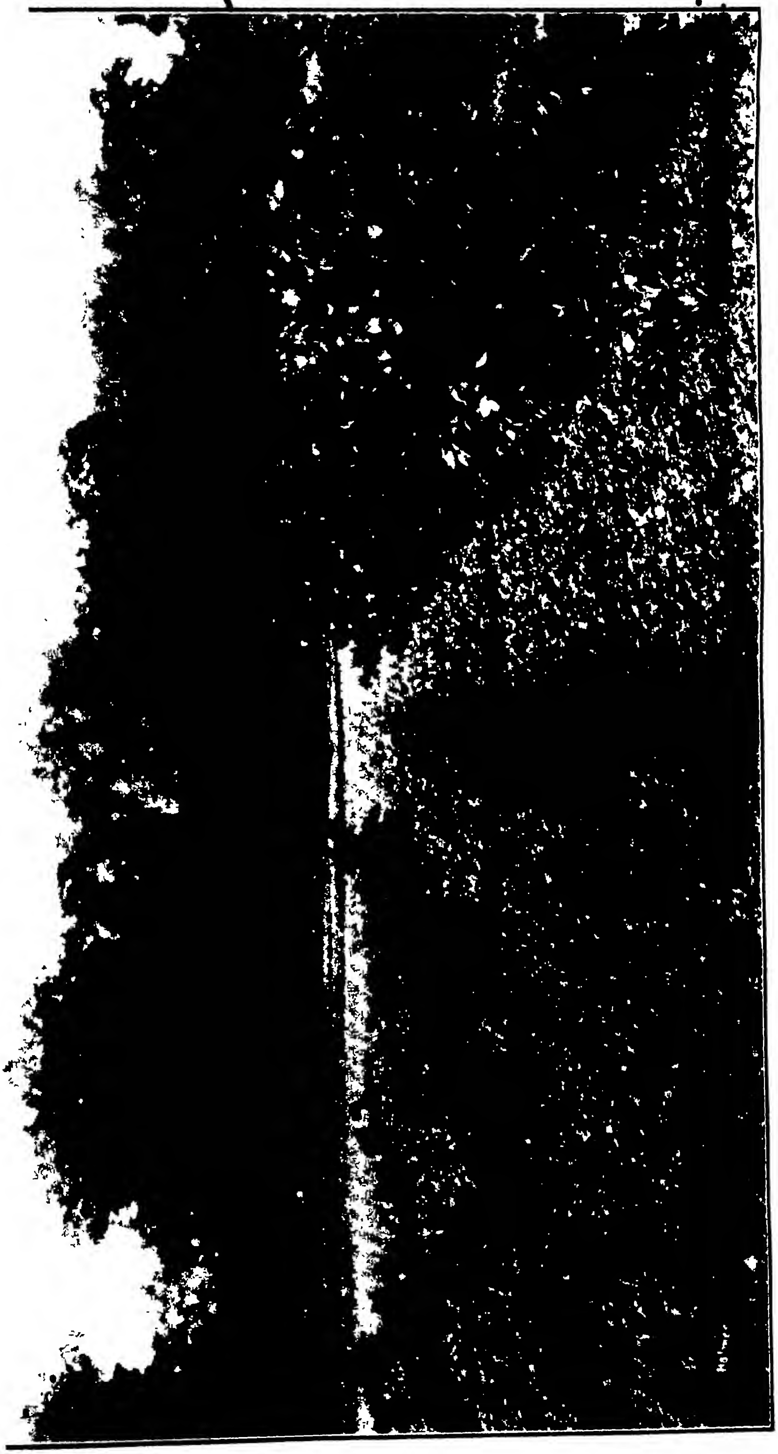
Agricultural Officer, North-West Frontier Province.

In the course of 8 years' perambulation in the gardens and orchards of the Punjab and the North-West Frontier Province, it has not been my fortune to see a mature grove of Malta oranges that could be described as vigorous and fruitful, yet there are many gardens and plots of Maltas in every district in the "land of five rivers," and tens of thousands of young Malta plants have been set out annually for many years past, and planting is increasing. It is the heart's desire of almost every colonist to establish a Malta grove as soon as he has set his house in order.

In these disappointing gardens the causes of failure which the owners propound are as varied as they are numerous, and views on the subject are usually emphatically stated. Some lament unsuitable soil, and are not comforted when it is pointed out that their Sangtaras close by are doing well. Others wish they had well water rather than canal irrigation, and they uphold their views by pointing to Maltas which are treated from wells as being more thrifty than their own. And very many blame their nurseryman, who, they say, has supplied Maltas budded on a stock other than that which they desired.

It is unfortunately true that the cultivation of oranges is not understood by many of those who hopefully plant: the Malta is not a little fastidious as to soil, and no fruit tree is more impatient of excessive or untimely irrigation and defective drainage; but the plates which illustrate this article strikingly



Left:- Malta budded on "Mitha."

Right

show that the suspicions of the growers who surmise that their trees are on the wrong stock may be well founded.

Maltas and Sangtaras alike, north of Delhi, are budded on the "mitha" or "sweet lime," the "khatti" or "small sour-lime," the "khatta" or "large sour lime," and the "gulgul" or coarse "citron." Each of the four vernacular names suitably describes the respective stocks to the Punjabi or the N.-W. Frontierman, but in the plethora of botanical names which each has received during the past century, it is difficult for the fruitgrower to decide which name he may most safely adopt in order to elude the criticism of the botanists. Though most nurserymen bud a proportion of their oranges on each of these stocks, every one holds decided opinions regarding the special suitability of one or other of the foster-parents used. The "mitha" is by all reputed to give thin-skinned and sweet Maltas. The "gulgul" is favoured by some nurserymen, because it most quickly produces a Malta plant fit for sale. The "khatti" is gaining in favour because of the vigour it is said to impart to the Malta and the Sangtara, and this stock is also said to sustain the trees to ripe old age. The "khatta" is not popular, and it is comparatively little used as an orange stock by experienced nurserymen.

With these and many other controversial points regarding cultivation, soil, etc., in view, it was decided to carry out, at the Peshawar Agricultural Station,—a trial of Malta and Sangtara oranges budded on each of the stocks named above, before launching out on extensive trials of oranges in groves. I have to confess that I was not free from bias regarding the merits of the various stocks. I favoured the "khatti" for the Malta and the Sangtara alike, and four acres of land were boldly planted with "khatti" plants for the future supply of fruits for the production of seedling stocks. My selection proved to be but half right. At Peshawar, Maltas are far more vigorous on the "khatti," but, strange to say, the Sangtaras are out and away happiest on the "mitha" and the "gulgul." (There is at least one nursery known to me in north India which has issued tens of

thousands of Sangtaras on the "khatti" during the past 25 years.) Plates IV—VII show Maltas and Sangtaras on the various stocks and the letter-press makes further explanation unnecessary. The results of the trials which are so strikingly depicted in the plates demonstrate which are the stocks that give greatest vigour to young Malta and Sangtara plants. The 60 trees on the respective stocks are remarkably uniform in growth, and in the case of the Maltas, a second or check plot similarly proved the "khatti" to be the stock which encourages early vigour.

But though it is true in plant growth as it is in most other matters that "well begun is half done," the question of stocks for the Malta and the Sangtara in India is not by any means solved by the trials at Peshawar. It is possible, though it is improbable, that climatic and soil conditions may lead to quite different results elsewhere. Then there are the questions of flavour, thinness of skin, date of ripening, early fruitfulness, length of days, and power to withstand excessive irrigation and maltreatment. The plum, for instance, declined to grow on its own roots or on the plum stock at Tarnab, but it throve and fruited splendidly on the peach foster-parent. The apricot is fruitful on the peach in Peshawar, but the wild apricot is more suitable for this fruit in the neighbouring district of Hazara. In fact, the question of suitability of stock is all-important in every fruit and it requires careful study in almost every garden.

Though my error in the matter of the selection of the "khatti" for the Sangtara and the Malta warns me to be careful, I would, in the light of recent observations, plant Maltas on the "khatti" and Sangtaras on the "mitha" if I were establishing an orange grove for profit in the Punjab or in the North-West Frontier Province. And this selection would probably gain the votes of the more extensive growers of oranges north of Delhi.

L :- Sangtara budded on "Mitha." Right:- Sangtara budded on "Khatti."

RYE-GRASS AND CLOVER IN INDIA

BY

W. ROBERTSON BROWN,

Agricultural Officer, North-West Frontier Province.

On the plains of North-West India there are not indigenous grasses which can be depended on to yield good cuttings for grass or hay between the months of November and May. The grasses of India, like those of the great dry-sub-tropical plains of the world, are sere and at rest during the months of cold weather. Barley and oats are valuable substitutes for grass during the season of scarcity, but these cereals yield only one green cutting, and comparatively poor aftermath on land of average quality.

A hardy vigorous grass which would provide green cuttings during the Indian cold season and a final crop of hay in early summer would be much appreciated by every owner of horses and cattle. To be successful in North-West India a cold season exotic grass must be hardy, and rapid in growth, and it would probably have to be an annual or a biennial.

In examining the more important early maturing fodder grasses of the world, Italian rye-grass (*Lolium italicum*) at once claims attention. It is admitted to be one of the hardiest of the "gramineæ," and it is a biennial; and in cold temperate climes it yields a green cutting and a crop of hay in the course of the short season. It is also ranked with the most nutritious and valuable grasses in the more intensively cultivated parts of the temperate regions of the globe.

Of the three species which are grown for green fodder and hay, *L. italicum* is the one which is most valued by the owners

of stall fed animals, and though it is unknown in a wild state it is recognised as a biennial form of the British Perennial rye-grass (*L. perenne*).

Lolium temulentum, the "Darnel" of English arable land, is common in the wheat fields of the Punjab and the N.-W. F. Province in May, and it was the abundant presence of this species of rye-grass in Peshawar which first suggested that *L. italicum* would probably be as useful in sub-tropical India, as it is in temperate parts of the world. It is interesting to note that the tares of Scripture are supposed to refer to "Darnel," and in English farm literature, this plant is described as a "noxious weed."

In the cold season of 1911, Italian rye-grass was most successfully grown at Peshawar and highly satisfactory crops of grass and hay have since then been cut from extensive areas in various parts of the N.-W. F. Province and the Punjab.

When it is grown for hay, rye-grass is everywhere associated with broad-red-clover, and the mixture is esteemed highly in English stables.

In North-West India there are two species of clover which have been found to thrive with rye-grass, *viz.*, shaftal (*T. resupinatum*) and Berseem (*T. Alexandrium*) and their clover grass and hay are excellent in yield and in quality. Broad-Red English-clover and rye-grass have also been grown with great success in Peshawar, but the clover does not at first keep pace with the more rapid growing rye-grass, and it is doubtful if red clover would succeed on grass farms which have warmer and shorter cold weather than that which prevails in the N.-W. F. Province. That there are possibilities in this clover even in India is shown by the fact that in Peshawar seed sown in October 1912 yielded a clover cut in April and a deep luscious crop again on 30th June when the temperature in the shade ranged between 110° and 115°F., and rye-grass was dead. At the present time (23rd August) this broad-red-clover is still growing vigorously and blossoming freely.

In order to obtain the best results, rye-grass—clover must be treated as a cultivated crop, like oats or barley for "khasil"

BROAD RED CLOVER at the Feshawar Agricultural Station.
photograph taken in June 1913, when the temperature in the shade ranged between 112.° and 115.° F.

and the following paragraphs briefly describe the treatment which has been successfully practised in the N.-W. F. Province.

Irrigation.—Abundant active soil moisture is one of the most important essentials in the production of heavy rye-grass-clover crops.

Soil.—Land which produces oats and barley "khasil" is well suited to rye-grass. Light dry gravelly soils yield poor grass crops.

Manure.—Rye-grass-clover can hardly be too generously manured, and if 10 tons per acre of stable litter is ploughed in before the seed is sown, and a light dressing is applied after each cutting of green fodder, three heavy crops can be depended on before the final cut is left for hay. Italian rye-grass is the fodder which yields the extraordinary grass crops on English sewage farms.

Rotations.—On the cultivated parts of grass-farm lands, the crops are almost all graminaceous, and reliance is placed on stable manure rather than on well planned rotations for the maintenance of the fertility of the soil. Rye-grass may follow any crop if the land is suitably manured.

Preparation of the seed bed.—The tillage which is given to land for cereals suits rye-grass-clover, but it is most important to obtain a firm, mellow, level seed bed for grass seeds.

Seed Sowing.—Rye-grass-clover seeds are sown broadcast *on* water directly after irrigation, and it facilitates even distribution if a little dry soil is mixed with the seeds.

The best results are obtained from sowings made in late August and early September, and it is not advisable to sow later than 15th October, though pure rye-grass, sown in January at Peshawar, has yielded a good hay crop in late May.

Seed Mixtures per Acre.

(No. 1).

Rye-grass-shaftal.

10 lbs. rye-grass.
8 lbs. shaftal.

(No. 2).

Rye-grass-Berseem.

40 lbs. rye-grass.

6 lbs. berseem.

(No. 3).

Rye-grass Broad-Red-Clover.

This clover has not proved that it will ripen abundant seed in North-West India. The seed might be procured from England and mixed with acclimatized rye-grass in the proportions advised by the seedsmen.

Rye-grass-Lucerne, broadcast.

30 lbs. rye-grass.

18 lbs. lucerne.

The proportions of grass seed to lucerne seed which are suitable to Indian conditions have not yet been accurately ascertained, and the quantities advised are meantime only approximate.

Cuttings.

If mixture No. 1 or No. 2 is sown in early September, on good land and under favourable conditions in North-West India, the first cutting should be ready on 15th November, the second in February, and the final crop for hay may be cut in May. Where manure and water are generously given, an extra green cutting may be expected, especially from rye-grass—shaftal, though the plants in this mixture are less solid and substantial than in the others. The weight of green fodder and rye-grass hay per acre which was cut at Peshawar in 1912-13 was fully equal to the clover hay crops obtained from average English rye-grass—clover meadows.

Advantages of Rye-grass-clover.

1. The rapidity and the cheap rate at which rye-grass —clover and its hay can be cut, are amongst the chief recommendations of the crop to North-West India. With few exceptions, Indian grasses must be cut by *khurpa* if their most nutritious and succulent parts are to be secured ; and the slow rate at which this work

must proceed is the cause of perhaps the greater part of Indian hay running to seed before it is cured. Rye-grass—clover, on the other hand, is quickly cut by sickle, and where the mower can be used, the crop is cut at the rate of about 1 acre per hour.

2. Rye-grass—clover yields succulent green grass during the cold season when indigenous grasses are not available, and where shaftal or lucerne are grown the admixture of rye grass greatly improves these green fodders.

3. Rye-grass—clover hay is entirely composed of valuable feed. A very large proportion of Indian grass-land hay is rejected by horses.

SOME EXPERIMENTS WITH MAIZE STORED IN BINS

BY

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Offg. Imperial Entomologist.

In October 1912 some experiments were started on the Pusa Farm at the instance of the Imperial Agriculturist to test various methods of preventing maize, kept for feeding cattle, from being attacked by insects. The maize was stored in large cylindrical bins six feet high and three feet in diameter, with a closely fitting lid, and holding between twenty-five and thirty maunds of maize each. In all, nine bins were used, eight of which A_1, A_2 —D_1, D_2 were carefully fumigated with carbon bisulphide and the last (E) left unfumigated. The bins were charged in the following way, the tests being made in duplicate except the last.

Bins A_1, A_2 Unfumigated Maize.

Bins B_1, B_2 Unfumigated Maize with Naphthalene.

Bins C_1, C_2 Fumigated Maize.

Bins D_1, D_2 Fumigated Maize with Naphthalene.

Bins E. Unfumigated Maize in an unfumigated bin.

Bins A would act as a control to B, C and D' and bin E to all the others.

The fumigation was in each case done with carbon bisulphide at the rate of five pounds per 1,000 cubic feet. The naphthalene was put in at the rate of one pound of flake naphthalene per bin this quantity being divided into four equal parts and wrapped up in fine muslin, and one package placed one-quarter of the way up

the bin, one half way, one three-quarters of the way, and one at the top.

The bins were all carefully sealed around the lid and down the seams with a mixture of white wax (1 part), fat (1 part), rosin (6 parts) melted together and applied hot, and were stored in the farm godown.

In addition to these bins a complementary experiment was started in the laboratory, glass stoppered bottles, each holding 300 grms. of maize, being used and 3 grms. of naphthalene tied up in muslin for those bottles which were charged with naphthalene.

The bins were then left undisturbed until March 1913 when some of the maize was required for feeding cattle and consequently bins A_1, B_1, C_1, D_1, and E were opened and examined and bins A_1—D_1 emptied, but bin E again closed and sealed. At that time not much damage was noticeable as during the cold weather the insects are not very active. A few moths (*Sitotroga*) were found at the top of bin A and a large number in bin E, but examination of samples taken from bins A—D failed to reveal any of the beetles which are generally lumped together under the name "weevil." The remainder of the bins were left undisturbed until July 24th when one hundred grains were taken out for a germination test, the bins afterwards being closed and sealed.

About this time also the bottles kept in the laboratory began to show results. The bottles corresponding with bins A_1, A_2 showed that insects were active inside them. Numbers of specimens of moths (*Sitotroga*) could be seen and quantities of dust and frass had collected at the bottom. The bottles corresponding to bins B_1, B_2, C_1, C_2, D_1, D_2, showed that the grain was being preserved successfully, no signs of insect attack being visible.

The final examination of the bins was made on September 29th, 1913. Bin A was found to be badly affected with "weevils" at the top and also a few moths. In bins B, C & D, the grain looked quite good. Bin E was, as one would naturally

expect, badly attacked. Samples were taken from the top, middle and the bottom of each bin and one hundred grains cut open and examined with the following result :—

Sample.	Bin No.	Insects found.
Upper sample	A_2	15 *Rhizopertha dominica.* 2 *Tribolium ferrugineum.*
Middle sample	A_2	6 *R. dominica.*
Bottom sample	A_2	2 *R. dominica.* 1 *T. ferrugineum.*
Upper sample	B_2	1 *T. ferrugineum* dead.
Middle sample	B_2	2 *T. ferrugineum.*
Bottom sample	B_2	1 *R. dominica.*
Upper sample	C_2	1 *Calandra oryzæ* dead.
Middle sample	C_2	2 *T. ferrugineum.*
Bottom sample	C_2	7 *T. ferrugineum.*
Upper sample	D_2	*Nil.*
Middle sample ..	D_2	*Nil.*
Bottom sample ...	D_2	2 *T. ferrugineum* dead.
Upper sample ..	E	13 *T. ferrugineum.* 2 *C. oryzæ.* 3 *R. dominica.*
Middle sample .	E	3 *C. oryzæ.*
Bottom sample	E	1 *C. oryzæ.* 4 *R. dominica.*

Of the beetles found it must be remembered that only *Rhizopertha dominica* and *Calandra oryzæ* actually damage the grains. *Tribolium ferrugineum* lives merely in the dust which is always to be found amongst grain. From the table it will be seen that the bin B_2 which contained ordinary maize and naphthalene, compares very favourably with the bin C_2 which contained maize fumigated with carbon bisulphide, the condition of both lots being very good.

It then remained to be seen whether the naphthalene had any effect upon the maize which would render it unsuitable as food for cattle. When the bins were opened in March, maize, which had been stored with naphthalene, was spread in the sun for four hours, crushed and fed to one bullock. [It has been found however that a little naphthalene is left behind and it is

probably better to expose the grain for from six to twelve hours.] The animal ate up the whole quantity and was not affected in any way. This was repeated when the remainder of the bins were opened in September with the same result. It is therefore clear that if the naphthalene is allowed to evaporate, it has no deleterious effect upon the grain from the point of view of fodder.

The bottles kept in the laboratory were also examined with the following result :—

Bottle.	Contents.	Insects found.
A_1	300 grms. unfumigated maize..	191 specimens *Calandra oryza*.
A_2	Ditto	126 moths.
B_1	300 grms. unfumigated maize and 3 grms. naphthalene.	*Nil*
B_2	Ditto ...	*Nil.*
C_1	300 grms. fumigated maize .	*Nil.*
C_2	Ditto ...	*Nil.*
D_1	300 grms. fumigated maize and 3 grms. naphthalene.	*Nil.*
D_2	Ditto .	*Nil.*
E	300 grms. unfumigated maize	164 moths

It seemed also desirable to test whether storing with naphthalene would have any effect on the germinative capacity of the grain. Accordingly germination tests in dishes were made, with grain from the bins and also from the bottles, the results being as follows :—

Sample.		No. of grains taken.	No. of grains germinated.	Percentage.
Bin A_2	Upper	200	27	13·5
	Middle	200	169	84·5
	Lower	200	166	83
Bin B_2	Upper	200	178	89
	Middle	200	183	91·5
	Lower	200	174	87
Bin C_2	Upper	200	185	92·5
	Middle	200	178	89
	Lower	200	186	93

Sample.	No. of grains taken.	No. of grains germinated.	Percentage.
Bin D_2 Upper	200	174	87
Bin D_2 Middle	200	182	91
Bin D_2 Lower	200	179	89·5
Bin E Upper	200	2	1
Bin E Middle	200	*Nil*	*Nil.*
Bin E Lower	200	*Nil*	*Nil.*
Bottle A_1	200	141	70·5
„ A_2	200	*Nil*	*Nil.*
„ B_1	200	184	92
„ B_2	200	166	83
„ C_1	200	191	95·5
„ C_2	200	192	96
„ D_1	200	188	94
„ D_2	200	189	94·5
„ E	200	1	

The grains which were taken from the bins on July 24th were sown in the Insectary compound and the number of plants which appeared counted. The result is as follows :—

Out of 100 grains from bin A_2 85 grains germinated.
„ „ „ „ „ „ B_2 83 „ „
„ „ „ „ „ „ C_2 92 „ „
„ „ „ „ „ „ D_2 91 „ „
„ „ „ „ „ „ E 80 „ „

The sowing was too late however for the plants to mature properly.

A comparison of all the results recorded above shows that storing with naphthalene is practically as effective as fumigation with carbon bisulphide, that it has no bad effect on the grain from the point of view of its suitability as food for cattle, and also does not alter the germinative capacity to any appreciable extent. It is therefore a much more suitable compound to use for preserving grain than carbon bisulphide, its advantages over that insecticide being :—

(1) It is quite easy to use. Carbon bisulphide is an extremely volatile liquid and the vapour when mixed with air

forms a very explosive gas. This necessitates extremely careful use, as in inexperienced hands it may prove dangerous.

(2) No special apparatus is required, the only precaution necessary is that the naphthalene should be enclosed in muslin or some such porous material to prevent it becoming mixed up with the grain. With carbon bisulphide a special fumigating house is essential and this is costly to build.

(3) The cost is much less. This is very important. Flaked naphthalene costs Rs. 16/- a cwt. or say 3 annas a pound. The charge used was one pound per bin holding twenty-five maunds, and of this after eleven months only about a half had evaporated (in bin B. 23¼ tolas were left and in bin D_2 23 tolas). For the fumigation of the maize used in this experiment, that is to say roughly a hundred maunds, seven pounds of carbon bisulphide were required, the fumigating house only accommodating about sixty maunds at a time and the charge for the house at five pounds per thousand cubic feet being three and a half pounds. The cost of this alone, exclusive of the additional cost of labour required to cart the grain to the fumigating house and then back to the store was about Rs. 7/-, the cost of carbon bisulphide being Rs. 12/- a gallon. The charge of naphthalene for a similar quantity of maize would be four pounds, of which only a half would be expended, and the cost of which would be 12 annas.

(4) The effect is continuous, as the naphthalene is stored along with the grain. The effect of fumigating with carbon bisulphide is to kill all the insects, larvæ, and eggs, in the grain at the time, but after fumigating the carbon bisulphide must be allowed to evaporate and any insects which found access to the grain could breed unchecked. The effect of the naphthalene is constantly to keep the insects in check. This is proved from a comparison of bins or bottles A and B which contained exactly similar grain and from the condition of A at the end of the experiment must have contained insects at the time of storing. The insects in A bred unchecked, whereas in B they were not able to do so, with the result that the grain in B was

as good as that in C in which the insects were all killed by the carbon bisulphide and insects prevented as far as possible from gaining access to the grain.

The use of naphthalene, then, is a simple way in which grain kept for fodder and for other purposes may be preserved from damage by insects, the only things to be remembered being that the naphthalene should be prevented from becoming mixed with the grain,* by enclosing it in muslin, and that the grain should be exposed in the sun for from six to twelve hours before feeding to the cattle.

* In this connection the use of naphthalene balls may suggest itself, but flaked naphthalene is cheaper, gives off vapour more easily, and above all, it is much easier to take out a package of muslin than to search for a number of loose balls which might easily be overlooked or broken up.

NOTES

General Rice Warehouses.—The *beiken-soko* or public warehouses for rice are among the most important social institutions of an agricultural character in Japan. Owing to the frequent fires and inundations, by which whole harvests either stored or still standing in the fields were damaged or destroyed, the need for such magazines had long been felt. These *beiken-soko* are only a special type of the *futsu-soko* or general warehouses. In them, farmers and traders deposit any portion of their rice crops which they wish to be well preserved.

These warehouses differ from the ordinary warehouses in that profit is not their object and that they receive no cereal but rice, which is carefully selected and classified. The *beiken-soko* are conducted either as joint-stock societies under a collective name, societies with certain members as guarantors, or as co-operative associations, and in certain cases they may be established as private enterprises. Federations have recently been formed, and there are three central warehouses. The business of the warehouses as social institutions consists in the care of the rice deposited, the issue of warrants for its value, in making advances to the owners, encouraging the cultivation of rice, supervising markets, consignment and transport, establishing exhibitions, and diffusing instruction in the use of manures, machinery, agricultural implements, etc.

The work is carried out thus: the farmer brings his grain to the *beiken-soko*, where after accurate inspection, if the judgment upon it be favourable, it is accepted and assigned to its proper grade or grades. The sacks are then sealed and are left in the care of the establishment. The farmer is given a warrant for the value of the grain, and a final receipt. The warrants

may be discounted with the warehouse association or with any bank which undertakes such transactions. Should the farmer wish to withdraw a portion of his rice, he addresses himself to the manager, presenting his warrant. On receiving his grain he must pay all charges for inspection, insurance, storage, etc.

The principal advantages of this system are : complete safety in storage secured by the perfect organisation of the warehouses in contrast to those of private firms ; greater facility for insurance ; economy of time and space ; facilities for buying and selling arising from the concentration of the rice and the absence of intermediaries. The disadvantages are : the easy falsification of warrants, or their irregular use, the limited advantage offered to the small farmer, and the opportunities afforded to speculators. But compared with the advantages, these disadvantages are of minor importance. As to the development of the *beiken-soko*, we have no information for the whole country ; we can only speak of the few which furnish returns. The deposits naturally vary considerably from one district to another according to the nature of the season and the amount of the crop. Isolated reports, therefore, can have no more than a relative value. However, to give the reader some idea of the movement, we may mention that in the warehouse at Sakata in the province of Yamagata, the oldest and most flourishing of the *beiken-soko* in Japan, the average yearly quantity of rice received amounted to about 166,000 hectolitres in the ten years 1899-1908.

(Summarised from the *Bulletin of Economic and Social Intelligence* of the International Institute of Agriculture, Rome. 4th year, No. 6, June, 1913.)

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LARGER CATTLE AND FODDER SUPPLY.—It has been urged against the use of larger cattle in India, that they require more food than smaller ones. This criticism would be valid, if the larger bullocks, while consuming as much food in proportion to their weight as the smaller, did relatively less work. But provided implements are adapted to the size of the bullock, the work done will be directly proportional to the weight ; while a larger

bullock requires, in fact, relatively less nutrient material, owing to its smaller proportional cooling surface (which varies as the square of the linear dimensions, whereas the weight varies as the cube). This is a principle recognized in scientific treatises on the feeding of animals, but discounted as between animals of different species, by the fact that smaller warm blooded animals generally have, by way of compensation, a relatively thick covering of hair or wool, or live in sheltered lairs.

The production of heat requires the consumption only of fats and carbohydrates, and we may therefore infer that the diet of a large bullock should be, in proportion, as bulky as that of a smaller one and should contain as much nitrogenous but less carbonaceous material. This implies a less concentrated but more nitrogenous food and suggests economy of starchy grains at the expense of a better quality of coarse fodder.

Now the great objection to the bulky fodder crops raised during the rains in India is the large amount of woody material they grow if allowed to mature. This can be remedied by cutting them green and curing as hay or silage; and if weak-stemmed leguminous crops are grown for fodder, alone or with supporting cereals, they cannot profitably be left on the ground so long as the more woody stemmed cereals alone.

On the other hand early removal of a rains crop permits of a partial fallow, with a view to the growth of an autumn or winter revenue producing crop, and it is therefore an obvious suggestion in connection with the employment of larger cattle that an effort should be made to grow and cure leguminous or mixed leguminous and grass crops, sown at the earliest possible moment at or before the beginning of the rains, cut after six weeks or so, and followed by immediate ploughing for an autumn or winter crop. This early catch crop would take the place, in intensive farming, of a green manure crop; the loss of the above-ground portion of the latter being offset by the greater amount of manure obtained from the larger bullocks.

An incidental advantage of the system would be the division of the monsoon, as regards cropping, into two distinct periods,

the failure of neither of which would seriously affect the other. This would prevent, in so far as such crops were grown, the loss of almost the whole season by a failure of the later rains, at least in the centre and north of India. It would also prevent the great loss of nitrogen that must often now occur in the first monsoon showers, on land that has been cultivated in the hot weather but is not sown early. And if it meant strenuous exertions to sow a larger area in a few days, at the first sign of the monsoon, this would be compensated for by the rest that the cattle would get while the resulting weed-smothering crops were growing. At the muggiest time of year, when fodder also is at its scarcest and the new growth on waste lands is only fit for grazing, the value and economy of such a rest is considerable.—[A. C. DOBBS.]

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THE potato moth has recently caused considerable loss to stored potatoes in both Farrukhabad and Lucknow. Preliminary experiments were carried out with storage in sand, both with and without the use of crude oil emulsion, in 1912, and it was found that better results were obtained with sand alone, thus confirming the results already obtained at Bhagalpur by Mr. Woodhouse. In the present year a godown was hired and potatoes were stored in order to demonstrate the financial results. The following table shows the receipts and expenditure per 100 maunds :—

EXPENDITURE.

	Rs.	As.	P.
100 maunds of potatoes at -/14/- per maund	87	8	0
17 cart loads of sand at -/12/- per cart	12	12	0
Sulphur for disinfecting godown ...	0	4	0
Labour	9	1	6
House rent for 7 months	21	0	0
Pay of chowkidar	29	5	9
Picking and storing charges	21	2	3
Total Rs. ...	181	1	6

RECEIPTS.

	Rs.	As.	P.
68½ maunds of potatoes @ 7/12/- per maund ...	530	14	0
Profit Rs. ...	349	12	6

The potatoes were probably purchased unusually cheaply this year owing to the fact that local dealers have largely given up storing owing to the loss incurred. Assuming the normal price at harvest time at 1/4/- per maund and the normal price of seed at sowing time Rs. 6/- per maund, it is still obvious that this method of storage not only provides for a sound supply of seed but also forms a profitable investment.—(B. C. BURT.)

RESTRICTIONS ON THE IMPORTATION OF NURSERY STOCK INTO THE UNITED STATES OF AMERICA.—A revised set of "Rules and Regulations for carrying out the Plant Quarantine Act" have been issued by the Government of the United States of America and published in the Supplement to the *Gazette of India* of October 18th, 1913.

REVIEWS

Agricultural Credit and Co-operation in Germany.

Up to the present time the Registrar of the Co-operative Credit Societies in India has been dependent for guidance both as to method of organisation and detailed *formulæ* on the works of Sir Fred. Nicholson of Madras and those of Mr. H. W. Wolff and Mr. C. R. Fay.

A monumental blue book (Cd. 6626) just issued by the Board of Agriculture and Fisheries entitled "An Enquiry into Agricultural Credit and Agricultural Co-operation in Germany" by Mr. J. R. Cahill brings together a mass of detailed information as to the methods of procedure in that country and is likely to form a useful guide for workers on co-operation in India and other countries. The author's commission was "to obtain full information in regard to the organisation and actual working of the systems of agricultural credit, agricultural co-operation and live stock insurance in Germany" and this colossal Report is evidence that he has faithfully discharged his commission.

The Report is too elaborate and exhaustive to admit of review in the ordinary sense of the word. The body of the Report contains a full and accurate description of all the forms of agricultural credit, agricultural co-operation, and live stock insurance, which exist in Germany.

But for the practical worker the most valuable parts of the Report are the appendices, which contain translations of the most important laws relevant to the matter in hand; the articles of Association, Company agreements, and statutes of representative organisations: business rules, credit regulations, specimen credit report: model balance sheets and forms of various kinds, and other documents likely to be of use to co-operators.

For these reasons the report is one which should be in the hands of every one who is practically concerned with the development of the Co-operative movement in India.—(EDITOR.)

***

Gopalan.—A HANDBOOK ON THE CARE AND MANAGEMENT OF CATTLE IN BENGAL BY SATYENDRA NATH MITRA.—Price 0-8-0. (Published by Anathnath Mitra, B.A., 38/9, Bosepara Lane, Calcutta.)

THE author of this booklet in *Bengali* introduces it as follows :—" There is no work in Bengali worth mentioning on the keeping of cows. I have, therefore, ventured to place this small treatise in the hands of the public as the result of the short experience I have gained for the last ten or twelve years as a Professor of the Government Veterinary College and a Veterinary Practitioner."

Indebtedness to Isa Tweed's 'Cow-keeping in India' first published in 1891 by Messrs. Thacker. Spink & Co., Calcutta, is, however, acknowledged ; and, as a matter of fact, the publication appears to consist almost entirely of a free translation of that book, of which it produces most of the original defects, adding many others due to bad translation, misprints, or deliberate alteration, and with no attempt to bring the information up to date. Some of these mistakes are merely ludicrous, as for instance 'some cows calve every year *or seven months*'—and the manure pit 'should be covered with an *inch or an inch and a half* of dry earth' ; others are misleading such as the recommendation that servants and store houses should be separated from the cowhouse by at least *one foot* (Isa Tweed in the original said 50 feet). In the appendix the author gives 29 recipes taken from Colonel Hallen's " More deadly forms of cattle disease in India," but there are no descriptions of the diseases for which these medicines are prescribed.

The best that can be said of this book is that if it misleads the amateur, he must be very much of an amateur, while any

cultivator who may be induced to buy it will, at any rate, get some amusement for his money.

But, involved in the attribution of this compilation to 'experience......gained for the last ten or twelve years as a Professor of the Government Veterinary College and a Veterinary Practitioner' are two serious questions—the more important of which is the reputation of the Bengal Veterinary College and of the Veterinary Department.

The reviewer, being unable to read Bengali, is indebted to Babu P. N. Das, Senior Veterinary Inspector of the Bihar Veterinary Department, for the materials on which this review is based.—(A. C. D.)

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ENSILAGE, BY DIGBY HUSSEY DE BURGH (PUBLISHED BY MAUNSELL & COMPANY, DUBLIN AND LONDON.) Price, 2*s.* 6*d.*

THIS little book (the letterpress consists of only 53 small pages of large print) can perhaps be best described as a polemic in favour of the use in Ireland of silage, as against hay, roots, and cake.

Its chief interest for agriculturists in this country is in the short chapter of 6 pages on the details of the making of concrete silohs, which is of value as being based on first hand experience in their building and use. The chapter is illustrated by a set of excellent photographs at the end of the book showing the method of supporting the scaffold and fixing the frames for filling with concrete in building the wall.—(A. C. D.)

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THE PUNJAB VETERINARY JOURNAL, ISSUED QUARTERLY BY THE PUNJAB VETERINARY ASSOCIATION, LAHORE. (Annual subscription Rs. 6/-.)

THIS is the only Vernacular Journal known at present, dealing solely with Veterinary subjects for the benefit of such assistants or *salutries* in the profession as cannot make use of the high class periodicals available in the English language.

An attempt at issuing a veterinary journal in Urdu was made as far back as 1890 by Col. H. T. Pease, then Principal of the Lahore Veterinary College, and it was conducted by him for about three years at great personal cost; but soon after his proceeding home on furlough in 1892, it ceased to exist. In 1896 it was started again and lived for ten years, to render valuable service to those it was chiefly intended for, but ultimately, for want of help, it met with the same fate as its predecessor. Then again in 1908 Major Dawson, a professor of the Lahore Veterinary College, undertook the publication of the Journal, but this too had to be stopped after a year owing to the same difficulties.

It is, however, a matter for congratulation to see it brought into existence for the fourth time from January, 1913, through the strenuous efforts of Col. H. T. Pease, Principal, Lahore Veterinary College. To place the publication on a firm footing the business of conducting it has now been entrusted to a managing committee of ten members, mostly from the College staff. The inclusion of such eminent Veterinary officers in India as Col. H. T. Pease and Major G. K. Walker, in the managing committee is a sufficient guarantee as to the information published being accurate and up to date.

The members of the Punjab Veterinary Association meet regularly almost every month, and papers on subjects appointed previously and clinical notes on selected cases are read and discussed, the proceedings being published quarterly in the Journal for the information of those interested in veterinary subjects.

The issue of the Punjab Veterinary Journal for April, 1913, under review, contains papers read and discussed on: (1) Rabies, by Chowdhri Haq Nawaz Khan; (2) Ulcers, by Munshi Gulam Rasool Khan Saheb; (3) Mammitis, by Syed Sirdar Shah Gilani; and (4) Ovariectomy, by Mr. Burke. The papers on Mammitis and Ovariectomy in the Journal are treated at sufficient length from every point of view and are both interesting and instructive. —(J. H.)

ELEMENTARY TROPICAL AGRICULTURE.—W. H. Johnson, F.L.S. (Obtainable from Thacker, Spink & Co., Calcutta.) Price 3s. 6d.

This text-book, though written primarily for West Africa, could be adapted *mutatis mutandis* to the teaching of elementary natural science in the tropics generally—wherever an attempt is being made, in primary and secondary schools, to combine the development of a school-boy's intelligence with the teaching of method and the expression of thought, and with the acquisition of useful knowledge in the easiest and most natural way.

Though it is possible that in India such books will, for some time to come, be required rather for educating the teachers than for reference in teaching, their number at present is lamentably small.

This being the case, we welcome this exotic, and the only criticism we wish to make is in respect of its title and introductory chapter.

The book has nothing at all to do with "Agriculture." It is a text-book of rural elementary scientific education with chapters on school gardening, and we are surprised that a man of Mr. Johnson's experience should allow this pernicious town-bred confusion of the idea of elementary scientific education with that of agriculture, to vitiate the cover and introductory chapter of his excellent text-book.—(A. C. D.)

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The Burma Economist * "a monthly magazine devoted to Agriculture, Industries, Commerce and kindred subjects" (Annual subscription, Rs. 5), made its first appearance in July, 1913, and the first few numbers enable us to form an estimate of its quality. We may say at once that this promises to be exceptionally high. The contributors include Mr. M. de P. Webb and Mr. Channing Arnold as well as Mr. C. Drieberg, Secretary of the Ceylon Agricultural Society, and Mr. A. McKerral, Deputy Director of Agriculture, Southern Circle, Insein, and

* Obtainable from the Editor, *Burma Economist*, 68, Lewis Street, Rangoon.

others whose names are a guarantee of literary merit, and the reviews of, and extracts from, other periodicals display a sense of discrimination rare in the offices of popular Journals—a quality which is also manifest throughout the editorial notes. We hope this enterprise will meet with the success that it deserves.—(A. C. D.)

***

THE *Indian Journal of Medical Research* is a beautifully got-up quarterly publication obtainable from Messrs. Thacker, Spink & Co., subscription Rs. 6 per annum. The first number contains, among other articles of medical interest, two from the pen of Mr. F. M. Howlett, on "The natural hosts of Phlebotomus minutus" and "Life histories of biting insects." In the first of these the author has shown that the common gecko or house lizard is the normal host of this sandfly; in the second he deals with the mutual adaptations of parasites and their hosts. The following suggestive aphorisms taken from the latter are perhaps of more than medical and entomological interest. On classification:—"the less important a morphological character is from the point of view of utility and success or failure in life, the more likely it is to furnish a reliable clue to the genetic relationship of its possessor;" and on parasitism:—"the general trend of parasitism is towards symbiosis."

Of interest from a veterinary standpoint are articles by Captains Patton and Cragg on "Certain Hæmatophagous species of the genus Musca" and "A new species of Philæmatomyia with some remarks on the genus."—(A. C. D.)

The Central Provinces Agricultural & Co-operative Gazette contains as usual many notes of practical and economic interest. In the July number, one of the most important relates to the manuring of cotton: figures are quoted, derived from the experiments on the Akola and Nagpur farms, which go to show that the application of 66lbs. of nitrate of soda to cotton when about 10″ or 1′ high, on land manured with a moderate dressing of farm-

yard manure in these districts, results in an increased net profit of over Rs. 22 per acre. This is noteworthy as being one of the few instances of economic success in the application of imported nitrogenous manures in India.

In the same number the Registrar of Co-operative Societies publishes the "Bye-laws for Co-operative Agriculture Unions in the Sihora Tahsil" and the "Rules for the guidance of Kamdars" attached to these Unions—notes which should be read by those interested in the system of seed distribution in the Central Provinces, described by Mr. Evans in a paper reproduced in the July (1913) number of this Journal.

In the September number of the Gazette a warning note is sounded by the Assistant Registrar who gives an account of a Co-operative Society which got into the control of two prominent members who used the money borrowed by the Society for paying off their private debts. The members then repudiated their liability, but a suit was filed against the Society and the whole of the principal and interest was recovered by attachment of the property of almost all the members. This should serve as a warning to all members of unlimited liability Societies to take a personal interest in their Society's management.—(A. C. D.)

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WE have received 'leaflets setting forth the aimz ov the Simplified Speling Sosieti' of which Professor Gilbert Murray, LL.D., D. Litt., F.B.A., is President, and are asked to state that 'Theez and aul uther informaishon will be gladli sent bi the Secretari ov the Simplified Speling Sosieti,' 44, Great Russell Street, London, W. C.

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AND

S. SUNDARARAMAN, M.A.

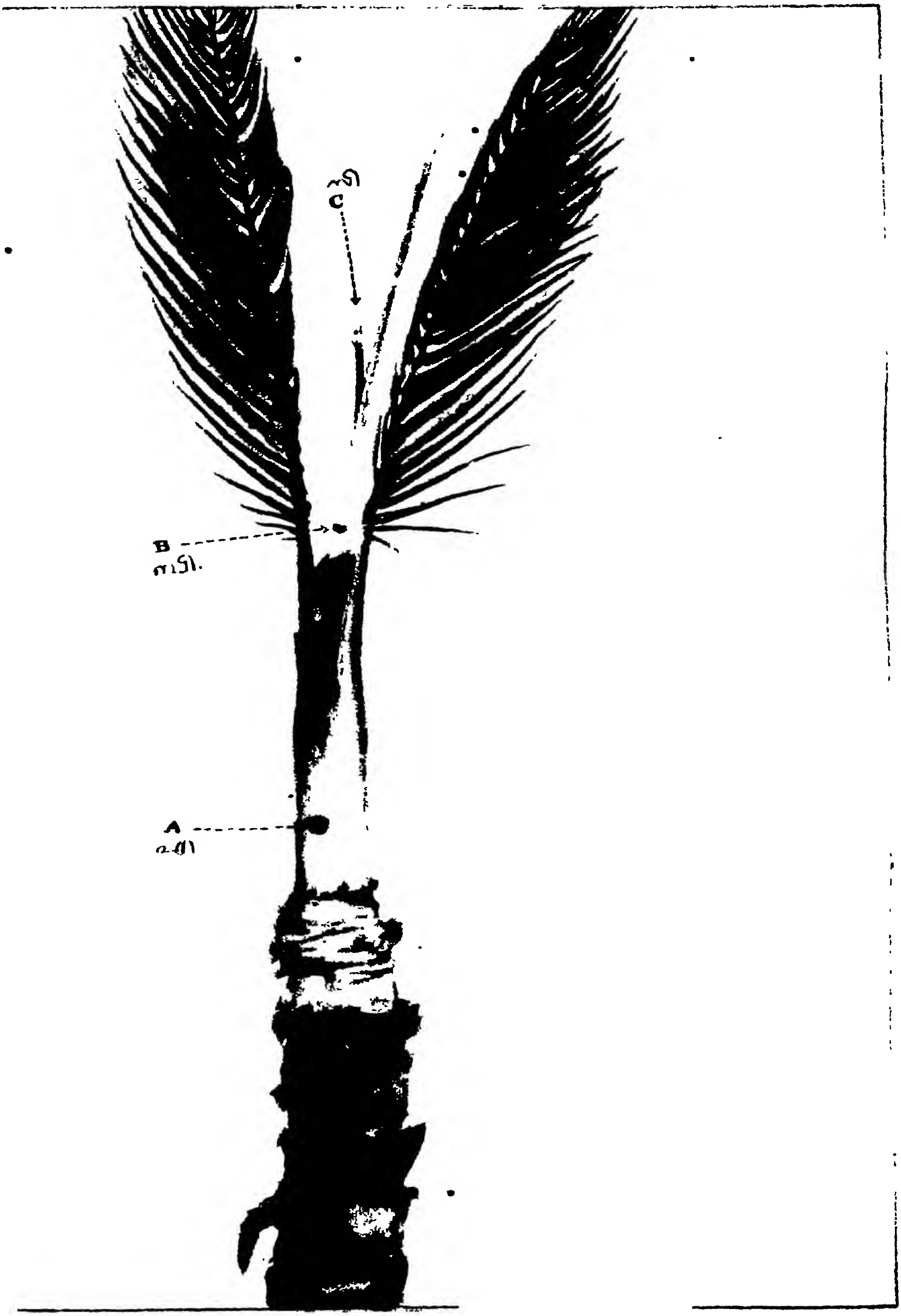
Few areas in the world are probably so dependent for their material prosperity upon the produce of a single crop as the coconut producing districts of South India. In parts of Malabar, South Canara, Cochin and Travancore, the coconut palm may be said to absorb nine-tenths of the capital and labour of the raiyats, while the general prosperity of these districts testifies to the handsome return which the coconut yields to cultivators. Any disease of coconuts, therefore, which threatens to become epidemic, would, if unchecked, deal a blow to the prosperity of the West Coast of which the effects would probably be discernible at the distance of a century. That palm trees are capable of suffering from epidemics, as severe as that which destroyed the coffee industry of Ceylon, has been shown in recent years by the history of the palmyra palm cultivation in the Godavari and Kistna districts. In these districts the palmyra palm suffers from a disease called "bud rot," due to a fungus eating its way through the soft tissues of the bud and producing a rot in the crown which finally results in the death of the whole plant. Owing to the fact that the fungus, while growing on the palmyra palm, produces myriads of minute spores or seeds, this disease is very infectious; for, under suitable conditions, these spores are scattered through the air and falling upon a healthy palmyra palm germinate and produce the fungus which at once proceeds to attack the bud. Since every diseased palmyra is a centre for the infection of healthy trees an obvious method of checking the spread of the disease is

by cutting down and destroying every palm as soon as it shows symptoms of infection. This has been done by Government on a large scale, and the virulence of the epidemic may be gauged from the figures of the number of trees cut and burnt. In the last five or six years the number of diseased trees destroyed annually in the Godavari district has been as follows :—

1908-09	...	...	...	...	...	141,235
1909-10	...	...	...	...	...	84,108
1910-11	...	...	...	...	...	63,433
1911-12	...	...	...	...	...	64,420
1912-13	...	...	...	...	...	71,009

While investigating the bud rot of palmyra palms it was found that the same fungus was capable of attacking coconut palms, but the evidence on the whole showed that the latter did not suffer to any appreciable extent.

In October 1912 the first report of a serious disease of coconuts in Malabar began to attract attention. The first outbreak noticed was at Tamarasseri, a village about 20 miles north-east of Calicut, on the main road to the Wynad. For several miles round this village cases of the death of single coconut trees in different gardens were common. In February 1913 the neighbouring amsams of Kidavur, Pallipuram, Karothur, Vavada, Poonur and Puthuppadi were inspected, and a number of diseased trees identified. The infected palms were in all stages of attack ; some palms 40 feet to 50 feet high and 20 years old were standing as bare poles, some about the same age had one or two yellow outer leaves but had lost the central shoot, while others had lost the central shoot but still retained the crown of green leaves. In a few cases young seedlings, which had been transplanted only a year before, were diseased, the central shoot coming away in the hand at a slight pull. Enquiries made in the locality seemed to show that the disease was of about ten years' standing ; the death-rate appeared to be very slow, only two or three trees dying every year, hence the raiyats were, on the whole, not apprehensive of the disease. At the season at which the first inspection was made the true cause of the disease was not identified ; the weather at this time was hot


C
B
A

and dry and it was thought that investigations made in the rainy season would probably yield decisive results. With this object, a visit was paid to Tamarasseri in the concluding days of July, at the height of the monsoon, when the nature of the disease at once became apparent.

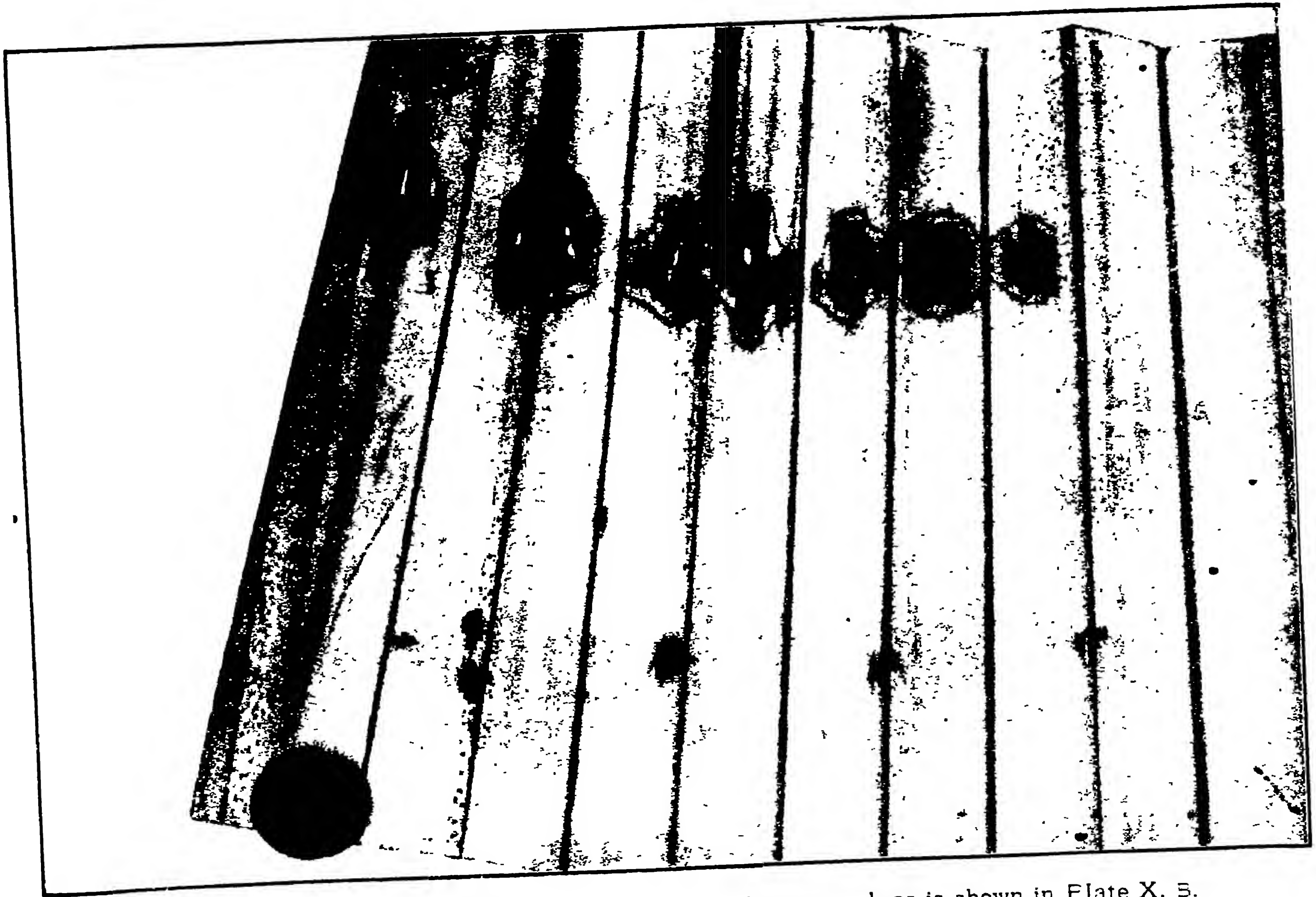
The nature of the disease was best ascertained from a study of young trees in an early stage of infection. The first symptom by which a diseased tree may be recognised is that the central leaf turns brown, collapses and dies. As everyone knows, the youngest central leaf of a coconut is folded up like a fan. If now the dead central leaf be removed and unfolded, it will be found that, at the point where the leaf has collapsed, the folded lamina is covered with a white fluffy growth of a fungus. This fungus, starting at one point on the leaf, eats its way straight through the folds of the lamina and produces a softening of the tissues leading to the collapse of the leaf at this point ; as a result of this the portion of the leaf above the point of infection turns brown and dies. In cases in which the infection is very recent, and the whole leaf has not had time to turn brown, the area infected by the fungus gives rise to very characteristic rows of spots. If, as sometimes happens, the attack does not spread beyond this point, then, when the central leaf expands, a row of brown spots in which the leaf tissue has decayed away can be seen stretching across the leaf.

In material from recently infected leaves it was possible to make a very complete examination of the morphology of the fungus which left no doubt that it was to be identified with *Pythium palmivorum* Butl., the cause of the bud rot of palmyras. On leaf spots, such as those illustrated, the white fluffy mycelium of the fungus bears abundant sporangia, and, under appropriate conditions, such as a supply of fresh rain water, these sporangia discharge their spores. In the case therefore of a tree in which the central leaf is attacked, it is easy to see how the infection spreads. A single day's rain would be sufficient to wash the spores down from the central leaf into the interstices of the leaf bases, where they would be in an ideal situation for the development of the fungus. In this way, and sometimes doubtless by infection

from other trees, the fungus forms rotten spots on the leaf bases. These spots may vary in size from an area as large as a rupee to one as big as the palm of the hand; they are a dark brown colour and present a fibrous appearance. The fibrous appearance is due to the fact that the soft portion of the leaf tissue is destroyed by the fungus, leaving the vascular strands running across the rotted patch; in and out between these strands a white mycelial growth of the fungus can usually be seen.

Once the fungus has become established in spots on the leaf bases it is a mere matter of time to the death of the palm. The mycelium eats its way in, passing from one leaf base to another, and finally reaches the growing point and kills the tree. As this goes on the outer leaves gradually droop and fall off while the spread of the rot is accelerated by various saprophytic fungi, bacteria and insects. In the final stage of the disease the tree is left as a bare pole with, possibly, a single discoloured leaf drooping from the crown. In the later stages of the disease, when the outer leaves are falling, it is not easy to identify the fungus, the apex of the palm is then a semi-liquid putrescent mass in which saprophytic organisms are extremely abundant. In the early stages of an infection it might be possible to confuse a case of true bud rot with an attack by Rhinoceros beetle. In true bud rot, however, the central shoot will come away in the hand, while in the case of an attack by Rhinoceros beetle the lower portion of the central shoot remains healthy, the upper portion, above the cut, being the only part which withers. Moreover, in those cases of bud rot in which the infection is recent, and the whole of the central shoot is not involved, the rows of spots on the folded lamina constitute a reliable criterion of distinction.

From a consideration of the habit of *P. palmivorum* it is not difficult to see how such a disease would spread once it was established in any one locality. On a windy wet day drops of water containing spores may easily be blown from one tree to another, while the practices of climbing trees for leaf cutting, thatching houses with leaves and tapping trees for toddy would also favour the dissemination of the fungus.



... diseased leaf arising from an infection such as is shown in Plate X. 5.

It is not within the scope of a popular article such as this to record the methods by which the fungus was obtained in pure culture or the course of inoculations; these matters will be the subject of a more scientific communication, but it may be mentioned here that of infections carried out in the laboratory with cultures free from any other organisms, either bacterial or fungal, about 75% were successful, the symptoms of the rot being exactly similar to that seen in the field.

At the same time at which this disease was diagnosed at Tamarasseri and the neighbouring amsams, it was also identified in other parts of Malabar. At Malappuram and Melmuri, in the south of the Ernad taluk, diseased trees, bearing the characteristic rows of leaf spots, were found; here also the disease appears to be of about ten years' standing. In the neighbourhood of Calicut itself several diseased trees were identified and found to be attacked by *Pythium*; while, in the vicinity of the Government Farm at Taliparamba, in the northern portion of Malabar, several virulent cases of infection were discovered. In this area the disease appears to be fairly well established in the amsams of Kurumathur, Andoor and Koyyam along the banks of the river Balipatam.

Up to the present the disease appears to be scattered throughout Malabar, but, fortunately, so far no single area has been found in which the incidence of the disease is as severe as in the case of the palmyra palms in certain taluks of the Godavari district; in the latter case it is by no means uncommon to find areas containing more dead poles than live palms.

It is unfortunate that both in the palmyra and coconut palms it is difficult to recognise the symptoms of disease in an early stage. This fact, coupled with the difficulty in applying any treatment to palm trees, renders the destruction of infected trees the surest method of controlling the disease. In the Godavari and Kistna districts the bud rot of palmyras was established before agricultural investigations had really been placed on a systematic basis in India. As a result the disease spread unchecked for some time, and when Government commenced operations they were faced with the presence of, probably, about 250,000 diseased trees in the

delta. It has naturally taken some years to make any impression on this number of trees especially as fresh trees are continually becoming inoculated. The position in Malabar is rather different in that the disease has been diagnosed at an early stage and treatment commenced. Provided one knew its whereabouts, it would probably be neither difficult nor expensive to destroy every diseased tree in Malabar; it is just at this stage in the disease that it is so difficult, and at the same time so necessary, to secure information of the occurrence of diseased trees. At the present moment active measures against the disease, on the lines of those in the Godavari, are in operation in Malabar. An officer of the Indian Civil Service with some subordinate revenue inspectors each one in charge of a district, has been placed on special duty and the destruction of diseased trees is in progress in the following localities:—Tamarasseri, Iyyad, Balluserei, Nanminda, Calicut, Malappuram, Kurumathur.

The following table shows the total figures of the work done up to date from the beginning of the operations :—

Amsam.	Sub-Division.	Trees Marked.	Trees Destroyed.
Tamarasseri	495	83	11
Nanminda	122	33	8
Malappuram	733	64	32
Balluserei	208	28	7
Iyyad	627	83	74
Calicut	1,363	61	18
TOTAL ...	3,548	352	150

It thus appears that about 352 diseased trees have been identified of which 150 have been already destroyed.

Of the factors influencing the spread of the disease, that most favourable to the growth of the fungus is the degree of moisture. In the palmyra palm disease in the Godavari a brief inspection of the number of trees cut every month serves to show the marked correlation between the relative humidity and the spread of the disease, a high death-rate being associated with a high relative humidity. In this respect the damp fogs which occur in the cold months in the Godavari district have a more potent influence than the actual rainy days of the monsoon, which sometimes alternate

with periods of bright sunshine. In Malabar the rainfall is far heavier and more continuous during certain months than in the Godavari ; indeed, in July at Tamarasseri, the authors have experienced 44 hours' continuous downpour, while the annual rainfall at Vayittri, about 10 miles away, is 169 inches, of which about 128 inches falls during June, July and August. During these months therefore the saturated condition of the air, and the water-logged state of the coconut palms, form ideal conditions for the spread of *Pythium palmivorum*. At the same time the excessive rainfall will almost certainly check the operations at this season, and it is probable that the months immediately succeeding the monsoon will be found to be the period in which the destruction of diseased trees may be prosecuted with the greatest energy.

Description of Plates.

Plate IX. A diseased coconut palm about 12 years old

The central shoot (A) is turning brown and withering.

B = green leaf, C = petiole, D = leaf base.

Plate X. A diseased coconut palm with the older leaves removed.

The spot A is a diseased patch containing the fungus which is slowly eating its way inwards ; B is another spot on the central shoot ; C is the youngest central leaf turning brown.

Plate XI. A row of spots on a diseased leaf arising from an infection such as is shown in Plate X B.

THE EIGHTH MEETING OF THE BOARD OF AGRICULTURE IN INDIA, AT COIMBATORE, IN DECEMBER, 1913.

BY

L. C. COLEMAN, M.A., Ph.D.,

Director of Agriculture, Mysore.

THE eighth meeting of the Board of Agriculture was, in many respects, a notable one. For the first time the South of India has been honoured by furnishing the seat for its deliberations. At the same time the field of its activities has been widened by the inclusion of representatives from the Civil Veterinary Departments in its membership.

Considering the distance which the great majority of the members had to travel the attendance was large. Forty-nine members attended the meeting, out of which number ten came as representatives of the veterinary service. There was also a large attendance of visitors, there being altogether twenty-six. Among these must be mentioned the Hon'ble Sir Robert Carlyle, Member, Revenue and Agriculture Department, Government of India, and the Hon'ble Sir John Atkinson, Member of Council, Madras, who represented the Governor of Madras in his unavoidable absence. The assistance and advice of some of the visitors at the meeting, notably the Hon'ble Sir Alfred Bourne, Director of Public Instruction, Madras, and Mr. W. Smith, Assistant Director of Military Dairy Farms, Poona, added greatly to the value of the discussions.

There were altogether eleven subjects for discussion. Out of these, three or four require little more than passing notice. The consideration of the programmes of Imperial and Provincial Departments evoked no discussion worthy of remark.

PLATE XII.

BOARD OF AGRICULTURE. 1913.

The third subject, "The Best Means of Bringing Improved Methods of Agriculture to the Notice of the Cultivators," stands on a somewhat similar footing. This subject has been down for discussion at every Board meeting since 1908 and while each succeeding report of the committee has brought fresh examples of the various methods for popularizing agricultural improvements, no new principles have been brought to light. The report of the committee and the subsequent discussion thereon, however, emphasized the growing importance of the co-operative movement in furthering the development of Indian agriculture. There are indications that this form of united activity on the part of cultivators will gradually replace, to a large extent, more loosely united and less responsible bodies such as agricultural associations, district committees, and the like, which it has usually been found difficult to pin down to definite lines of practical work.

Before leaving the subject we must not, of course, forget the additional purpose that its repeated discussion serves, *viz.*, to emphasize the fact that the Agricultural Departments in India are not losing sight of the importance of directing their energies to practical ends, and that they have already attained a striking measure of success in this direction. It must to many of us seem a pity that a constant insistence on this fact is necessary. Nothing is more repugnant to the average scientific worker than self advertisement, but, until the people at large are educated to a much higher plane than at present, the necessity for beating the tom-tom will unfortunately remain.

Of all the subjects which came up for discussion, the one which undoubtedly excited the most interest and attention was Agricultural Education. This subject had, previous to the meeting of the Board, been considered by a special committee of Deputy Directors with the object of ascertaining their views as to the course of study most suitable for the training of men for district work and work on experimental farms. Since 1906, when the standard curriculum for agricultural colleges in India was framed, much experience, some of it bitter, has been gained, and the subject was approached in an attitude very different from that displayed eight

years ago. It must, however, not be forgotten that the then President of the Board, Mr. Sly, in his introductory remarks pointed out the impossibility of laying down a fixed course of study which would be applicable to all India. That his views have been amply justified the experience of the last seven years shows only too clearly.

Thorough knowledge of local conditions and close adaptation of measures to suit those conditions are things the necessity of which is being continually insisted upon by Agricultural Departments in India and wherever failure has occurred it has been almost invariably due to an ignoring of these important points. There is no doubt that where failure or partial failure in connection with agricultural education in India has occurred, it has been due, to a very large extent, to a neglect of these two fundamental principles.

The most important feature of the discussion on this subject was thus the insistence on the impossibility of having a uniform curriculum and on the necessity of adapting agricultural education in each province to the particular needs of that province.

Another important point insisted upon was the advisability of framing courses of instruction of a more practical and less scientific nature. It was the general opinion that such courses would, in many cases at least, more closely satisfy present needs than the rather ambitious courses which are at present being given in agricultural colleges.

Other points whose importance was emphasized, were the necessity of close co-operation between the Educational and Agricultural Departments in developing rural education along lines best suited to rural needs and the advisability of experimenting with vernacular agricultural schools as a means of training the sons of the better class raiyats. Altogether it must be said that the discussions in connection with agricultural education were very fruitful, and that as a result the subject is likely to be dealt with by local Agricultural Departments in a much more rational and practical manner than has been the case in the past.

The Dairying Industry in India was a new subject upon which but few of the members could speak from practical experience. The Board was, however, fortunate in having as a visitor Mr. W. Smith, Assistant Director, Military Dairy Farms, and it is not too much to say that to his advice and assistance was largely due the admirable report submitted by the Committee on the subject. Probably the most important single point in the report was the emphasis placed on the possibility of breeding a dual purpose animal in India, *i.e.*, one that, while retaining the admirable draught qualities belonging to so many Indian breeds, would at the same time show milch qualities much superior to those now possessed by most of the Indian races of cattle.

The consideration once more of the Indian Sugar Industry, which, it will be remembered, formed the chief subject for discussion at the 7th Board meeting, was important mainly in that it gave the Board an opportunity to hear of the immense amount of work which has already been done by the Sugarcane Expert, Dr. Barber. Those who, in addition to hearing Dr. Barber's report, also saw the work being done on the cane breeding station, situated a short distance from the college farm, must have felt that at last this subject is beginning to receive that practical and scientific treatment which its economic importance deserves.

Cattle-breeding and Fodder Supply, although these subjects had received a certain amount of consideration at previous Board meetings, had never been discussed in a thorough manner. The excellent report of the Committee to which they were referred for consideration formed the basis for much discussion. The chief points emphasized were the dependence of cattle improvement on fodder supply, the necessity for an increase in the staff of the various Departments so that more time may be devoted to the subject of cattle-breeding, and the importance of investigating existing and other possible sources of fodder supply with reference to their availability and suitability. The general feeling of the Board was that in the pressure of other more insistent work this important phase of agricultural improvement has been largely neglected by the various Agricultural Departments in the past. The importance

of the subject warrants the formation of special Animal Husbandry Sections and undoubtedly something like this will have to be done if any marked improvement in Indian cattle is to be effected.

The utilization of the Veterinary Department for the dissemination of preventives against cattle diseases and the introduction of prophylactic measures, was a subject which led up to a consideration of the important question of cattle insurance and the following resolution with reference thereto was presented by the Committee and passed by the Board :—"Inasmuch as a centralised department is at a great disadvantage in undertaking propaganda for improved methods, either of agricultural or veterinary practice, among an unorganised population, this Committee would welcome the establishment in every province of a system of Cattle Insurance on co-operative lines as the best means of creating a strong public opinion in favour of improved cattle hygiene and would express the hope that the Registrars of Co-operative Societies may see their way to reconsider the resolution come to at their 6th Conference and to raise no objection to the establishment of co-operative cattle insurance societies where the Veterinary Department can guarantee facilities for inoculation on the outbreak of disease."

Of the other subjects which were down for discussion Rice was found too large, Drainage and Conservation of Soil Moisture too indefinite for really fruitful discussion. On the other hand, it was felt that Fruit Culture, although in some sections of considerable importance, is not universally so in India and that therefore no general recommendations could be made.

It would be showing a lack of proper perspective not to mention two addresses which were delivered by visitors at the Board. The first of these was the address by Mr. Arno Schmidt, Secretary of the International Master Cotton Spinners' and Manufacturers' Associations. This speech bore striking testimony to the value of the work already done by Agricultural Departments in India from an economic point of view and made a strong plea for more generous appropriation of funds for agricultural work on the part of the various Governments in the future. The second was the address

by the Hon'ble Sir Robert Carlyle which closed the proceedings of the Board. This speech was a generous recognition from the representative of the Indian Government of the striking progress that has been made by the Agricultural Departments in India within the last ten years.

This progress made by the Departments is more or less reflected in the biennial meeting of the Board and in no way is this shown more strikingly than in the gradually rising level of the debates. Not many years ago, the discussion of questions brought before the Board was practically monopolised by a few with greater knowledge or greater boldness than the rest, and the discussions themselves were only too frequently of a vague and general character. This is rapidly passing away. The scientific officers of the Department are finding their feet and are now usually able to base their conclusions on something a little more stable than inferences from results obtained in other parts of the world. So short a time as six years ago when the writer first attended a Board meeting the discussions were practically restricted to the various Directors and half a dozen of the senior scientific officers. At the Coimbatore meeting there was scarcely a member who did not take an interesting part in the discussion, while most of the visitors also actively aided in the deliberations.

MELON CULTURE IN PESHIN, BALUCHISTAN, AND SOME ACCOUNT OF THE MELON-FLY PEST.*

BY

JAMES CLEGHORN, C.E.

Peshin—				
Altitude	...	...	...	5,000 feet.
Rainfall	...	...	...	8 inches.

THE varieties of melon grown in Peshin are as numerous as the varieties of paddy met with in Bengal.

The indigenous melons are in shape all more or less oval, with seeds conglomerated by some glutinous substance into three slabs, disconnected from the edible portion. When over-ripe, the glutinous matter becomes watery, and the seeds then separate from each other. The colour of the seed is pale yellow.

The manner in which sub-varieties are produced would be an interesting study, but in this note I shall only give a superficial sketch of the principal varieties, with their methods of cultivation, sufficient to explain my observations and investigations into the life-history of the pest, the amount of damage it causes, and the remedies applied by the Pathans to check the damage.

As regards the correct naming of the sub-varieties, I have found the natives at fault, on account of there being a great family likeness among the sub-varieties. I have also extracted maggots, pupæ, and dead flies from melons, which native experts have declared, after careful and searching examination of the rind, to be free from attack.

Samples of flies, maggots in all stages of development, eggs and pupæ have been reared from all descriptions of melons, cucum-

* A paper written in September 1890 and printed in the *Journal of the Agricultural and Horticultural Society of India*, Vol. IX, Part I, New Series, to which it was communicated by the Government of India

PLATE XIII.

bers and vegetable-marrows, and forwarded to Mr. E. C. Cotes, Editor of *Indian Museum Notes on Economic Entomology.**

The life-history of the fly is as follows :—

Egg stage	4 days,
Grub "	11 "
Pupa "	13 "
Fly " about	20 "

In the pupal stage the animal hibernates from September to April, some even commencing this period from July.

From May to August two or more broods are produced ; thus, by the end of July, the pest has increased in such numbers that the cultivation of melons is seriously affected.

The egg of the fly is longish, pointed at both ends, opaque—white in colour, and visible to the naked eye. It is deposited below the rind in a hole made at right angles to the rind by a pointed gauge-shaped implement attached to the ovipositor of the fly. Five eggs are generally deposited in this hole. The early morning is the time that flies are to be found busy depositing their eggs in the very young swelling fruit, even selecting those with the flower still attached. The young fruit, if not badly attacked, rapidly increases in size, and when four days old, or in size about four inches long by three inches in diameter, the position of the eggs, caused by the growth of the melon, will appear altered, and, instead of lying just beneath the rind of the fruit, will be found three-quarters of an inch away embedded in the pulp, with a faint hair-like line leading to the original hole in the rind. As soon as the eggs hatch out, the young grubs make their way to the seed pulp, leaving the remains of their egg-shells behind, and causing very little damage to the edible pulp.

When the fruit is about ten days' old, the hole in the rind disappears with all traces of the young maggots' progress through the pulp. In the melon, even with powerful glasses, I have failed

* The specimens were forwarded to Mons. J. M. F. Bigot, who kindly examined and described the insect as *Carpomyia pardalina*, a new species which belongs to the group of Muscidæ distinguished by Rondani as *Tephritoidi* and is hence allied to *Tephritis onopordinus*, Fabr. *Indian Museum Notes*, Vol. II, 1890, pp. 24-25.

to discover any semblance of an air tunnel to enable the grub to command a supply of air from outside. So I have come to the conclusion that the necessary supply of air is to be had from the centre of the fruit. That air is necessary for the maggot's existence, is shown by the fact that in the cucumber and vegetable-marrow, the young grubs have to remain near the original hole in the rind, eating out a cavity in the pulp, which wound causes these fruits to become distorted in shape, and, eventually, when there is no chance of the wound closing up, the grubs make their way to the seeds; but very poor specimens of flies are reproduced out of these fruits.

In bad seasons the young fruit of the melon is sometimes so severely punctured, that it fails to make any growth, and in this state it rots before the eggs hatch out. Five eggs do not appear to have any effect on the growth of the melon, but any larger number above this causes the fruit to become stunted. I have extracted as many as one-hundred-and-thirty eggs from a young melon four inches long, the size showing the age to be about four or five days, but I have never counted more than eighteen maggots from a half-grown fruit; it would, therefore, appear that there is some difficulty in the way of the young maggot safely establishing itself in the seed pulp. I account for this loss in young grubs to be from those eggs deposited late, or after the melon is over two days old, as the more juicy the fruit becomes by growth, the more difficult it would become for the young grub to succeed in working its way to the seed pulp, without becoming suffocated by the juice from the pulp. The remains of egg-shells, found in the pulp as previously described, may include the remains of some of those grubs unable to establish themselves.

The maggot, when full fed, is like a grain of fine table rice, its mouth is armed with a pair of mandibles hooked at the ends, its posterior is not as blunted as in the generality of maggots, and it shews, by two brown spots, the usual organs for breathing.

When the maggot is only a day or two old, it is more difficult to discover than the egg, on account of its transparency, only the brown breathing organs generally expose its position in the pulp.

During the time the grub is feeding on the seeds and pulp surrounding the seeds, it constructs tunnels to protect itself from the fruit juice accumulating by gravitation at its posterior, but if the fruit is turned over, the grub has to leave off feeding and commence new protective tunnels in other directions, that will drain by gravitation at its posterior end, and so keep the tunnel clear for obtaining its supply of air; but if the fruit has not been disturbed, the grub, after about fifteen days from laying of the egg, commences to leisurely eat its way through the edible pulp towards the rind, which it takes about two days to reach, when it cuts its way out, head foremost, and goes to earth under the fruit.

If the melon is juicy and well-developed, it always cuts its way out through the uppermost and most exposed part of the fruit, and it is by the observation of this habit that natives successfully prevent the grubs from cutting out of the fruit by simply turning the fruit over at a certain period once a day.

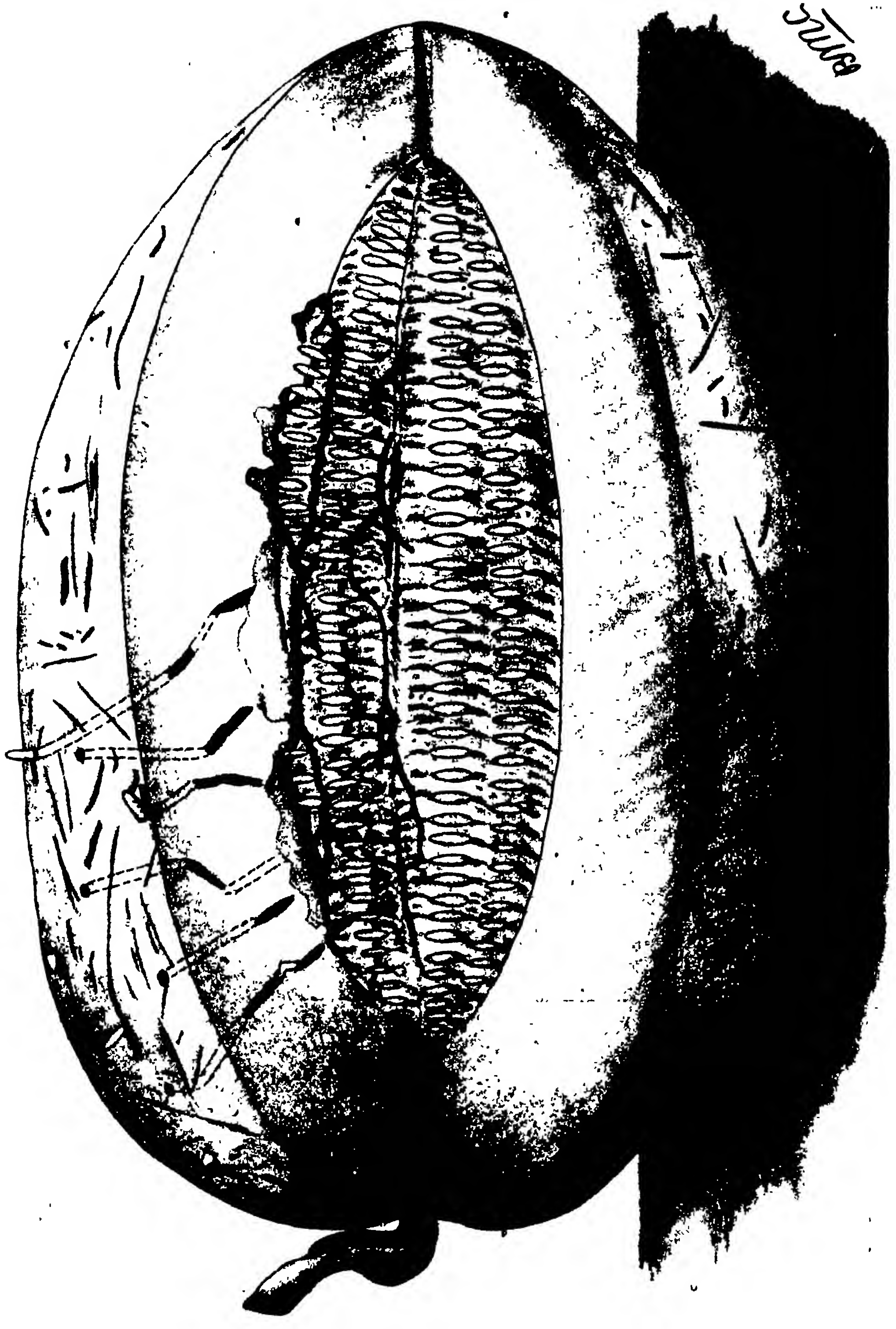
The only information I could gather from the natives as to the reason why daily turning the fruit was practised at a certain period, and for a certain time, was, that the fruit so treated ripened equally throughout, and that this treatment had nothing whatever to do with preventing the grub from cutting out; this explanation seemed reasonable, and I was by it for some time thrown out in my investigations; but the questions were continually before me as to why the grub should always select the most difficult and tedious way for making its escape from a well-formed fruit from that part furthest away from the ground on which the fruit rests? And why should it leave the fruit head foremost, when other maggots dropped out of their host with their posteriors foremost?

In the silkworm-fly maggot, the maggot, after being full fed, drops out of the body of the silkworm always with its posterior presented to the outside air or towards its source of air-supply. With the melon-fly maggot, the maggot, after puncturing the rind, wriggles out, apparently with great labour, head foremost, keeping its posterior, in which are situated its breathing organs, presented towards the centre of the melon. I was therefore forced to conclude that the melon-maggot was entirely dependent on its

air-supply from air naturally contained in hollows about the seed pulp in the centre of the fruit, and I think that I will be able to show, with very little doubt, that this must be admitted as a fact.

In all probability some ancient Pundit discovered the true reason for the grub's inability to cut out of the melon if the fruit, during a certain period in its cultivation, was daily turned over, but the Pundit's great difficulty must have been to discover a rule to suit the people, whereby his discovery might be brought into practical use. For had he preached forth his discovery by stating that a melon contained five or more maggots, when he could produce no entrance holes in the perfect rind of the fruits, he would not for one moment have been credited, and besides cutting open unripe melons weighing only two seers, or half their proper weight, for general instruction, would be wasteful ; and, again, our Pundit in a good season could not be certain of producing grubs out of one in twenty melons, as this is about the percentage of attack at early periods in ordinary good seasons. He knew that it was useless to explain that by turning the melon daily for six days after it had attained the age of fifteen days, or a day or so before the life-history of the maggot shows it to become full fed, would cause the tunnels being made by the maggots for exit, to become filled with fruit juice by gravitation, and thus cut off the air-supply, and so prevent their escape, and force them for want of time to pupate inside the melon ; and thus before the fruit was ripe, force the perfect insects to emerge into the cavity of the fruit imprisoned, and without chance of escape from being drowned in its juice, such a theory would be still less believed in ; so, as the portion of the fruit resting on the ground does appear to remain unripe and always causes a blemish to the external appearance of the fruit, the Pundit grasped the situation and thought that, to cause the fruit to ripen equally, and remove the natural blemish and make the fruit more attractive, the fruit during cultivation, after it has attained the age of fifteen days, must be daily turned over for six days ; so this is at once understood and is admitted as part of the technical practice in melon cultivation.

I have given this illustration to show that our Eastern rules of practice are founded on scientific basis, but are taught in a manner



to suit an ignorant and superstitious people, the true meaning remaining hidden; so our mission now is to sift all evidence and re-discover the reason Why? and place the results properly on record.

A successful remedy for the extermination of this pest is, therefore, in the hands of the cultivators; for, if the turning over of the fruit was universally practised early in an ordinary season, the pest would be exterminated; but the cultivator, as usual, is too dilatory, and is becoming more independent of leaders,—leaders who, in times gone by, extracted payment in kind in return for their spiritual and technical teachings; but the cultivator in his ignorance is now commencing to take to leaders who are only qualified to instruct in politics, and who are not so exacting; so, in his practice, he only observes the rule with those fruits which promise to attain size, leaving the stunted fruits to propagate the fly species.

After the maggot has successfully cut out through the uppermost part of the melon, it lets itself down to earth and takes shelter under the melon, and in some cases, if the soil is loose, buries itself about an inch below the surface, when its larval skin gradually hardens so as to form a case; it remains in the pupa stage until its period of transformation arrives for development into the perfect insect. The grub has not the power to burrow deeply into the earth, and its power of locomotion is also limited.

The chrysalis of the grub can always be discovered under the melon or its remains. It is very bouyant in water; so the first heavy shower of rain floats it away to other districts, whilst other districts float their chrysalides on to us.

Experiments on the vitality of the chrysalides in water have been made with the following results:—

2nd day	no loss.
3rd „	11 per cent. dead.
4th „	24 „ „ „
5th „	33 „ „ „
8th „	48 „ „ „
10th „	60 „ „ „
15th „	81 „ „ „
20th „	98 „ „ „
21st „	all dead.

The melon-fly in general appearance is of a light brown colour, and in size about that of a house-fly. Its head is disproportionately large for its body; its forehead supports two very short antennæ of a light brown colour, and set a little back, are the eyes, of a brilliant torquoise green. The probocis is of a brown colour and not very prominent. The thoracic shield is divided by a central line of dark brown, on either side of which is a broad line of lighter shade. The two side edges of the shield are handsomely ornamented by four black dots of irregular shape, displaying shiny spots on their surfaces. The point of the shield is ornamented by three black dots, the central one being much reduced in size, but made more conspicuous by a circular border of white. Of the three dots, only two are visible from above.

The thorax is of a light brown colour and is supported on the usual complement of three pairs of legs, also of a light brown colour. The abdomen is pear-shaped, of a light brown colour, ornamented by four segmental dark brown lines. The wings are vitreous, of ordinary size, held away from the body. Each wing is ornamented by four brown stripes shaded neutral tint, the two stripes at the extremities of the wings join at one end forming a V.

Pairing commences as soon as the flies burst out of their pupa cases. The female selects young fruit about two days old into which to deposit her eggs. She cannot succeed in puncturing the rind of a healthy melon of over four days' growth. The position of the puncture on the rind is shown by a small projection of gum of a reddish colour, which dries and falls off in a few hours, after which it is impossible to tell, by outward appearances, if a melon is punctured or not.

In confinement the fly dies in five or six days if food is withheld, but if food is supplied in the form of a cut melon, it appears to live for about twenty days. I found that cages made up of ordinary mosquito net would not hold the fly, so I substituted muslin, forty meshes to an inch; even then, some flies managed to work their way out, but only when they were still moist and before their wings had expanded.

This pest has this year increased to an enormous extent, and, for the first time, has started its attack on the cucumber and vegetable-marrow. The reason for this increase is that the late winter was a very mild one, no snow having fallen, and other climatic conditions during spring and summer, such as continued cloudy weather, with slight showers, have been favourable conditions for its increase.

As raiyats in Bengal are quite contented to squat for a few days on the roofs of their huts when their country is under flood, on account of the enormous benefits the land derives from being flooded, and on account of the wholesale destruction of pests floods cause; so the natives of this country will contentedly pass days shut up by snow in their miserable dwellings, on account of the enormous amount of good done to the land, and the enormous amount of damage all pests sustain; besides it is only snow gradually melting at a temperature when there is practically no evaporation, that supplies the natural storage reservoirs of the country's springs.

Therefore, a severe winter with snow is what the cultivator of this country desires, for the freezing of the soil so thoroughly disintegrates it, as to take the place of deep cultivation, and the gradual melting of the snow so thoroughly saturates the land, as to cause destruction to the abodes of pests hibernating in the soil and makes their escape a difficulty when their period of hibernation is over.

It can, therefore, be seen why snow storms here and floods elsewhere, cause cultivators of the land to become transported with joy on their seasonable occurrence, although, to those not interested in cultivation, these events are catalogued as dire calamities requiring prompt State interference.

Six inches of snow in winter, which represents half an inch of rainfall, will produce more good in destroying pests and in filling up natural reservoirs than any amount of rain in other seasons; in fact, any rainfall, above our average of eight inches, would cause a corresponding amount of damage to our cultivations and to our reservoirs.

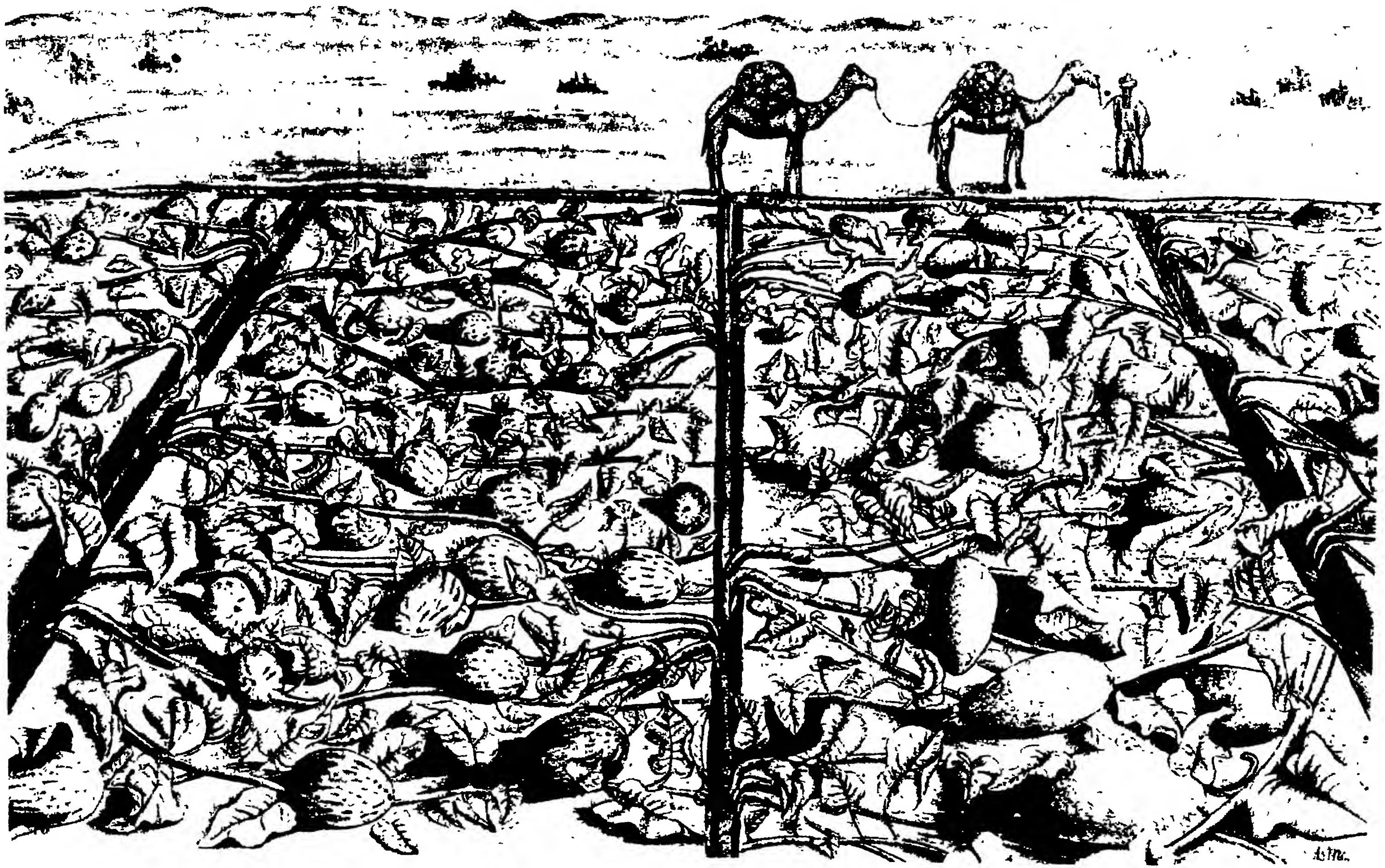
Twenty inches of rainfall in a year would produce as severe a drought and pestilence in this country as the absence of rain for three consecutive years would do in Bengal, heavy rain scouring the drainage and lowering the spring-levels of the country.

If we could have our rainfall to order, we would elect to take half our allowance as snow during winter, and dispense with rain at other seasons, this would suffice to fertilize our land, kill off our pests, and fill natural reservoirs to overflowing. For the general conditions required in this country for successful cultivation are irrigation from natural spring sources to the roots of the plant, and a dry cool atmosphere. Even when leaves become loaded with dust no water must be applied to cleanse them, but the dust may be removed by brushing with a piece of cloth.

Melon cultivation is practised in ordinary light soil, but, on account of the pest, never for two consecutive years on the same land, or within half a mile of the old spot.

The field is laid out in trenches about fifteen to sixteen feet apart, starting at right angles on either side of the main irrigation channel. The trenches are two feet wide by eighteen inches in depth, and on both sides of these trenches just above water-level are sown, during April, the seeds, three together, in holes scraped by the hand about three feet apart, and the vines resulting are trained over the spaces between the trenches. Every eight days the trenches are filled with pure clear spring water, as irrigation to the roots of the plants only. It is a great point in melon cultivation that the water used for irrigation must be of the cleanest description, and in no way charged with offensive matter. This is a drawback, as all the fly-blown melons are kept well out of the way of the trenches for fear that, by their rotting, they will contaminate the water; otherwise nothing would be easier than to cut off all stunted and fly-blown melons and drown the grubs in the trenches. It is said that if pure water is not used during cultivation, the fruit, when eaten, will produce serious illness.

Brackish hard water is the best suited for melon irrigation, the water being so highly charged with salts that should it be used for



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drinking purposes by anyone unaccustomed to it, a severe attack of colic will result.

The first melons were to be seen in the market about the first week in July, and these fruits showed an abnormal percentage of attacked, about twenty per cent.; whereas, in ordinary good seasons, the percentage at this time, July, is usually less than five; so by the first week in August, when the ground was loaded with fruit, the pest had increased in such numbers that the cultivation of all the "*Gharma*," or musk-melon varieties, had to be abandoned, and the loss thus sustained by the cultivators could not have been less than nine-tenths of expected produce, or in value Rs. 720 per acre.

The "*Sardah*," or water-melon varieties, have not suffered to the same extent, as the mode of cultivation differs. In this case the loss this season is estimated at about Rs. 500 per acre.

Melon plants will go on flowering until about the middle of September, but no flowers will produce fruit worth plucking after the 20th August, or as soon as it commences to be decidedly cold at night.

Varieties of melon. —There are two great classes the "*Gharma*" or heating, the "*Sardah*" or cooling. The former is the musk-melon, and the latter the water-melon; but from outward appearances, the two can hardly be distinguished from each other; even the formation of the seed slabs in both is alike.

The "*Sardah*," or water-melon, has a watery smooth rind of dark green colour marked with blotchy black stripes; but another better known and later variety has a yellow rind with an intermittent net-work of tape-like veins of greyish colour. Both are oval in shape with pointed ends.

The edible pulp is solid, snow-white, crisp and extremely juicy, with a delicate flavour of water-melon and musk-melon combined. It attains a great size, weighing from ten to fourteen pounds.

A rare variety of this melon has a green pulp and is of superior flavour to the kinds with snow-white pulp.

The "*Sardah*" is a favourite with the pest, as its rind being soft and watery, the fly can deposit her eggs through the rind of a

sickly melon of eight days' growth, but if the fruit is badly attacked it remains stunted and immature, but still quite fresh to all outward appearances, and in this state I have known eggs to be deposited through the rind of a fruit twelve days old.

The age of the fruit can be approximately told by the growth of the seeds remaining uneaten by the grubs, but it is not possible to tell the age of a badly attacked melon from outward appearances, until maggots show signs of cutting out.

The "*Sardah*" is also a favourite with the cultivator, as the very young fruit, with flower attached, can be buried inside a heap of dry earth, and so kept out of reach of the fly. The cultivator for this purpose carefully examines the three or four fruits forming on the end of a vine, for the external signs of gum drops showing the presence of flies' eggs beneath the rind. The fruit that shows the least number of these signs, or that which shows no signs of being punctured, is selected for being covered over. All the others with the flowers and buds on the selected vine are removed, and the end of the vine snipped off at about three inches from the specimen chosen. The selected fruit is then placed on the ground in a slightly raised position and a basketful of dry loose earth is heaped over it. This practice is successful against the fly pest, and it causes no harm to the development of the fruit, but it bleaches the rind of the fruit to almost pure white. After fifteen days the earth covering is removed, and the fruit is now daily turned over during the next six days, when it rapidly assumes its natural colour. The fruit takes in all forty days to mature, but, for the remaining nineteen days, nothing will harm it except rain. The arrangement for turning over the fruit at a certain period is remarkable as supplying direct evidence that the turning over is to prevent the chance cutting out of any grubs if the fruit should have been attacked before being covered over with dry earth. The life-history of the maggot inside the fruit is, egg four days, grub fourteen days : or eighteen days in all. The care taken of the fruit by turning it over is for six days, that is, from the fifteenth to the twenty-first day, thus exactly covering the period when the maggot is ready to cut out, and yet the natives assert that this arrangement

has nothing to do with preventing the grub cutting out, but the discovery of pupæ and dead flies inside melons proves and my experiments show the true reason.

The "*Heraty*." This is a late variety of water-melon and is cultivated like that above described. It takes sixty days to mature, but this makes no difference in the life-history of the egg and grub.

Its colour is of a bright yellow, and in shape round and ribbed. Being a late variety, it keeps good for some time if carefully stored stem upwards.

The "*Garmah*," or musk-melon.—All melons under this head are much sought after, but unfortunately their cultivation is limited, as they will not stand being covered over with earth as a protection against the fly. They are only available up to the end of July, the advent of the pest fixing the limit of cultivation.

The rind of the ordinary musk-melon is of a salmon colour shot with green, with a complete net-work of flat slightly raised grey veins. The edible portion is of a pale pink, solid, crisp, juicy, fruity and extremely sweet. The shape is oval like the water-melon, but the ends are not so pointed. The fruit attains a weight of from four to seven pounds.

The rind is of a drier nature than the "*Sardah*," so the fly cannot puncture the young fruit after it has attained four days' growth, not even if the fruit remains stunted and immature. The remedy to prevent the grubs cutting out is to daily turn the fruit over between the fifteenth and twenty-first day of its growth, but this is only practised on those fruits which have attained any size, all stunted fruits being passed over and maggots allowed to cut out of them. This is but natural for my experiments show that the turning over of the fruit has the effect of preventing maggots cutting out if only six or eight are present, but if more than this number be present, the fruit becomes very much less juicy, in fact, there is then no juice in the fruit capable of running by gravitation into the tunnels; hence, maggots can bore out in all directions without chance of suffocation.

I visited a field in the middle of August and was astonished to see the whole cultivation abandoned with the land loaded with stunted fruits, averaging each from two to four pounds rotting on the ground, from which maggots had been allowed to cut out. The plants were still growing, producing fresh fruits, and flies were busy depositing their eggs into the young fruits.

The grubs cause practically very little damage to the edible pulp if they are prevented from cutting out, but if once the rind is punctured, the fruit loses its market value and commences to deteriorate, ferment and rot.

The "*Thurma.*"—This is a variety of musk-melon. The rind is green, with a complete net-work of salmon coloured, raised flat veins. The edible pulp is of a light green colour, and its flavour far excels that of any other variety, being that of a strawberry in combination with the sweetness of the pear. I only succeeded in securing one fruit of this rare variety. I also came across another rare variety, a scented melon, having the pleasant scent of ripe apples, but of ordinary flavour.

The "*Hinduwana.*"—This is the Bengal water-melon, introduced. It retains its round shape, but attains a very superior flavour. The sponginess of the edible pulp entirely disappears, and it ripens thoroughly throughout right up to its rind, which it does not do in Bengal. Its sweetness is so increased, that it can be eaten without the addition of sugar. The edible pulp is of a bright red colour with dark brown seeds. The seeds are distributed in separate cells, the greatest number being found close up to the rind. No seeds form in the central portion of the fruit. The price of this melon is always exactly half the price of the indigenous varieties. Its keeping qualities are good.

This melon is occasionally attacked by the fly, but reproduces very poor specimens of the perfect insect, and these from stunted fruit only. The attack of the fly is accidental, but this causes considerable losses in young fruits. If not badly punctured, the fruit is capable of recovering from an attack, as from its watery nature the grubs cannot establish themselves, and thus become suffocated, and their remains absorbed by the fruit. No grub, pupæ or dead

fly have been recovered from a "*Hinduwana*" of ordinary size.

The remedy I would suggest as protection against the fly pest, more especially for the musk-melon, which will not stand being buried, is that each selected fruit should be placed in a light muslin bag, six inches broad by eight inches long, the mouth of the bag being drawn close round the stem, supporting the fruit by a thread.* When the fruit so protected attains the age of six days, the bag could be removed and placed over some other selected fruit. In this way, one bag could be used for the protection of about twenty young melons against the fly during the season.

If it was intended to take a heavy crop off the land, of say forty thousand melons per acre, the requirements per acre of bags would be two thousand in number, at a cost of not more than Rs. 100. Without bags or some protection against the fly, it is only possible to produce about two thousand five hundred melons per acre, locally valued at Rs. 800, but with protection and proper cultivation in the climate of Peshin and that of many other places, land could be made to produce forty-thousand melons per acre valued at Rs. 14,000; so even if the labour in fixing and removing each bag cost one pice per fruit, the cost per acre for this labour would be only Rs. 625.

To show how risky and yet paying an industry melon cultivation is, I will try and make a comparative analysis between the rude methods now practised, and what can be done if a successful and practical remedy could be introduced against attack from the fly.

The present method is to sow down a very much larger area than the raiyat can possibly look after, as by this means he manages to out-number the flies, for if one in twenty fruit remain sound, the raiyat is satisfied, as he even then gains a handsome profit. Even in

* As plants of the melon family bear bi-sexual flowers, and the difference between the sexes is apparent to the most casual observer, it would be an easy matter to fertilize the flowers as they open, and put them into the bag at once, so as to shorten the time they would be open to the attacks of the fly. Owing to the size and formation of the flower, the operation would be simple and could be performed very expeditiously.

a season like the past where, by the appearance of the fields, one might be led to fancy that the raiyat had become bankrupt, close enquiries show that he is quite satisfied, as he has managed to secure with very little trouble one melon out of nine, which has given him the handsome return of Rs. 806 per acre, the remaining eight melons being damaged by the fly at a loss of Rs. 6,448 off the same acre.

The "*Sardah*" I have stated attains a weight of 10 lbs., and the "*Gharma*" 5 lbs., so the raiyat trains on each vine two of the latter to one of the former.

The area allowed for the vines, three in number from each seed hole, is 18 square feet, and they are trained to attain a length of five feet, the vine being prevented from throwing out branches. When the vine is five feet long, one fruit, if it is a "*Sardah*," or two if a "*Gharma*," are allowed to develop, and the end of the vine snipped off about three inches above the selected fruit, all other buds and flowers being removed.

When the vine, so treated, has on it a well-developed fruit of about twenty-five to thirty days old, a branch is encouraged from which another fruit is cultivated, whilst the first one is ripening; and if the season is favourable, the vine may be trained to produce a third fruit. It is therefore apparent that from the three vines trained from three seeds planted together, it is possible to reap nine "*Sardahs*" or eighteen "*Gharmas*," weighing a total of 90 lbs. from 18 square feet of land, during a season lasting five months. Eighteen square feet of land represent $\frac{1}{2,420}$th part of an acre.

But eighteen square feet is about twice the area necessary for training three vines, nine square feet ought to be ample, and the crowding would help to keep the ground cool and fruit protected from the sun's rays. Therefore with a proper system, an area of nine square feet could be made to yield fruits giving a total weight of 45 seers or 90 lbs., selling locally at the rate of one anna a seer. An acre is, therefore, capable of producing 217,800 seers of this fruit of a value of Rs. 13,612, or nearly twenty tons of fruit containing a large amount of saccharine matter.

Even in this land of melons, the fly makes it practically impossible to produce the "*Gharma*" or musk-melon variety largely, and I would ask, how many can say that they have tasted any of this delicious, wholesome fruit ? Every one possessing a garden should, in the month of April, lay out a small plot for the cultivation of the musk-melon, protecting the young fruits by roomy muslin bags. Much pleasure with profit may be derived from the experiment, and if this description of melon can be sown during August and September, the melon cultivator will commence enquiries, the *malies* will rob samples of melons and bags from their masters and sell them to the raiyats, the raiyat will take these samples home—for has he not paid for them—and will divide the fruit with his people and try the effects of the bag on some favourite vine. As the time is fast approaching when he will be able to become rich without fearing the power of his Sirdar, and without fearing the murderous jealousies of his neighbours, he will not think twice of spending Rs. 100 in bags so that he may reap a return in thousands. The time, too, is not far distant when Railway Companies will run special fruit trains from Chaman to different parts of India ; but to hasten the time, the railways will have to show that every precaution is taken to prevent their station *khalassies* from causing wanton damage to parcels of fruit. So, the sooner the Railway Companies can prove that they can transport fresh fruit without damage, the sooner will the raiyat be induced to increase his production.

Even as it is "*Cabul Melons*" are sold in the bazars all over India, and find their way as far as Calcutta, but the best types are never tasted out of the country.

It may not be out of place to record a few experiments made in packing fruit for transport.

For grapes the best packing material is half dried fresh grass. Large bunches should be divided, and the grapes packed in layers between a good padding of grass very tightly pressed. The whole secret lies in pressing down the grass on the grapes as tightly as possible, and it is astonishing the amount of pressure the grapes can withstand. This description of packing has stood the test

of a journey of six days by rail, with three days' exposure *en route* to the sun on different railway platforms, the grapes arriving, after nine days, quite fresh. The late varieties of grapes stand long journeys the best. Bazar grapes are always washed before being exposed for sale, this washing destroys all chance of grapes being able to withstand packing.

Peaches, nectarines, plums, etc., should be packed like grapes, but they must be hard and very raw to withstand such a journey. Apples have been successfully despatched long journeys by wrapping each in a small piece of newspaper and packing in layers with three or four whole sheets of newspapers between each layer.

All packing should be done tightly, in narrow boxes, to prevent heating, and air-holes made in the box in every direction.

MANGO CROPS, AND SOME FACTORS INFLUENCING THEM.

BY

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THE common expression "a good mango year," or "a bad mango year," is so universal and familiar that we are apt to accept it as representing an established order of things, without inquiry into the causes.

The importance of the mango crop to India is such as to warrant investigation into its periodicity. Unfortunately no reliable statistics for the whole of India are available to illustrate this point.

The statements as to its being a good or bad mango year are so casual in reports wherein such might be looked for, as to render it difficult to draw any conclusions.

The following extracts from old reports for 27 years, of the Government Botanical Gardens, Saharanpur, may serve as an illustration of how the mango behaves as regards fruiting—for a certain portion of India.

1886-7.—Full average crop.

1887-8.—Very light, almost a failure.

"I attribute the lightness of the crop to the presence of myriads of the mango-fly *(Idiocerus)* upon the trees while they were in blossom. This insect is found here upon the trees during the whole summer and appears to subsist upon the juices of the leaves, flowers, and of young tender shoots, but it commits most damage when the trees are in blossom, by injuring the reproductive organs

of the flowers, and thus causing interference with the setting of the fruit. Various measures have been tried for its extermination, but so far without success."

1888-9.—Good and above the average, no damage being done by insects or storms.

1889-90.—A complete failure. "The trees instead of flowering profusely as they generally do, made a most luxuriant growth of leaves. The cause of this leafy growth cannot be satisfactorily explained, but it was probably due to the abnormal weather experienced in the autumn of 1888. In September of that year we had a fall of 19″ of rain followed by a long spell of dry and comparatively mild weather. This heavy rainfall and subsequent mildness kept the mango trees in an excited and growing condition, and the wood formed then may not have been sufficiently ripened for carrying the usual complement of flower buds."

1890-91.—Light.

1891-92.—Lightest on record.

"The cold season of 1891 extended well into the month of April, and being thus considerably prolonged, this abnormal condition of weather appeared to have some effect on the production of the mango blossom. Trees in sheltered spots flowered profusely ; but the great majority flowered very sparingly, and in some cases not at all."

1892-93.—"Was one of the best we have had for several years past, but owing to the early and protracted hot season, the bulk of it ripened within an abnormally short period of time. For a short season mangoes were quite a drug in the market and were sold at lower rates than ever before experienced. The crop, though a good one, was thus far from profitable to the fruit contractors, owing to its failure to ripen in succession, as in normal seasons."

1893-94.—Bore most profusely.

1894-95.—An almost total failure.

"In this district, an average mango season usually lasts about two months, that is, for about that length of time fruit is plentiful, but last year the mango season scarcely lasted a month."

1895-96.—Extremely light.

" The trees flowered fairly well, but owing to the presence of insect blight they did not set fruit so plentifully as the show of blossom would lead one to expect.

" It may not be quite in place to draw comparisons between the past and current seasons in a report supposed to be only dealing with the past one, but I cannot help remarking on the profuse manner in which the mango blossomed this spring. Almost every tree met with was laden with blossoms from top to bottom and so profusely in many instances that the foliage was entirely hidden by the flowers. Notwithstanding the great show of blossoms, the crop of fruit during the coming season will be again light. Insect blight was not present to any great extent, nor were there unseasonable showers of rain while the trees were in flower ; therefore, I can only attribute the lightness of the current crop to the extreme dryness of the air caused by the prolonged drought having possibly withered up the organs of fructification before fertilization could be effected. This would affect the following year's crop."

1896-97.—" Notwithstanding a profuse show of blossoms, the mango crop for the third season in succession was a light one."

1897-98.—Moderate to good.

1898-99.—Excellent.

1899-1900.—Moderate.

1900-1901.—Considerably under the average.

" Seedling trees of the coarse stringy mangoes bore heavy crops in some of the groves in the district, but the crop carried by the choice grafted kinds grown in the garden was very light."

1901-02.—Nearly a total failure.

1902-03.—Moderately good.

" Mangoes carried great quantities of blossom, but the crop did not set well."

1903-04.—Almost a complete failure.

" This was due to the flower buds which lie at the end of the younger shoots having been blighted by the severe frosts which were experienced in the cold season of 1902-3."

1904-05.—Exceptionally heavy.

1905-06.—Very light.

" A condition mainly due to the frost of the previous cold weather. In a few cases young trees were completely killed, while in all the older trees the exposed branches were destroyed to a length varying between 3′ and 6′ below the growing points."

1906-07.—Abundant.

1907-08.—Almost complete failure.

1908-09.—Good.

1909-10.—Failure due to insects.

1910-1911.—Failure.

Flower destroyed by rain.

1911-12. —Bad.

Flowers injured by rain.

1912-13.—Best on record.

To show the above extracts more concisely, the following table is added :—

Table showing the yearly Crops.

Year.	Below average.	Average.	Above average.	Remarks.
1886 ...	...	×	...	
1887 ...	×	...	...	Due to insects.
1888 ...	...	...	×	
1889 ...	×	...	...	Due to luxuriant growth.
1890 ...	×	...	...	?
1891 ...	×	...	...	Due to frosts.
1892 ...	...	...	×	
1893 ...	...	...	×	
1894 ...	×	...	...	?
1895 ...	×	...	...	Due to insects.
1896 ...	×	...	...	Due to drought.
1897 ...	...	...	×	
1898 ...	...	...	×	
1899 ...	...	×	...	
1900 ...	×	...	...	?
1901 ...	×	...	...	?
1902 ...	...	×	...	
1903 ...	×	...	...	Due to frosts.
1904 ...	...	. .	×	
1905 ...	×	...	...	Due to frosts.
1906 ...	...	...	×	
1907 ...	×	...	...	Due to rain and hail.
1908 ...	...	...	×	
1909 ...	×	...	...	Due to insects.
1910 ...	×	...	...	Due to rain.
1911 ...	×	...	...	
1912 ...	...	...	×	
27 ...	15	3		

Average	...	11 %
Below	...	56 %
Above	...	33 %

From the above table we can make the following deductions :—

Deductions from the Table.

I.—*Failures.*

1. Insect blights are responsible for three failures.

2. Drought in the spring for one failure.

3 Prolonged frosts and cold are responsible for three failures.

4 Untimely rains at time of blossoming are responsible for three failures.

5 Luxuriant growth, due to rain and favourable growing period at the end of the rains, is responsible for at least one year's failure.

6. Four years' failures are unaccounted for, but were probably due either to rain or cloudy weather interfering with pollination, or to luxuriant growth.

7. Out of 15 failures, 11 are due to external agencies.

II.—*Average.*

1. No two average years succeed one another.

2. An average year may follow a bad or good year.

3. The comparative number of average years are very small, showing that the crop is usually either bad or very good.

4. The annual yield is probably modified by the law of alternating fruiting years.

5. The average for one year (1902) is explained as due to the fruit not setting well, notwithstanding profuse blossoming.

III.—*Above Average.*

1. On two occasions two abundant years occur in succession.

2. This is seemingly against the theory of alternating fruiting years. This however only occurred when there had been three bad years previously.

3. Three non-fruiting seasons would therefore seem able to support two good-bearing years in succession, provided no outside agency intervenes.

For the sake of comparison, the reports of the Government Gardens of Lucknow and Nagpur, have been drawn upon—

Lucknow shows, out of 30 years, 19 below average, 6 average, 5 above average crops.

Nagpur for 9 years, gives 6 failures, and 3 good years. If we go into percentages we find that—

	Below Average	Above Average.	Average.
Saharanpur has	56%	33%	11%
Lucknow "	63%	17%	20%
Nagpur "	67%	33%	?

As we are concerned chiefly with failures, we find that these three gardens together show a percentage of 62 failures. In all three places, the causes alleged for the failures are the same. They are—

1. Blight (due to insects).
2. Frost.
3. Extreme heat or dry hot winds when flowering.
4. Cloudy weather, rain, storms or extreme humidity of the air when flowering.
5. Exhaustion through heavy cropping the previous year.

It will be noted that with the exception of one cause out of the five given, they all refer to the flowering period. The blooming period therefore is the most critical in the history of the crop. It is not easy to define how the above five mentioned causes should be arranged in their order of importance, as some no doubt will vary very much both in time and place. I should however myself assign No. 5 as the most frequent cause of failure. The next would be No. 4, and the remaining three may be classed almost equal, with probably No. 3 as the least frequent. It is significant how comparatively few 'average' crops are recorded. I take it that the term 'average' here would be about midway between a failure and a heavy crop, or in other words a moderate crop. The reason for this is easily explained. Of the five causes of failure, four are external, and one may be called internal or inherent to the plant. Of the four external agencies three are climatic, and therefore practically beyond control, but the last is open to be controlled. All these causes are completely effective and cannot be modified, that is economically, with the possible exception of the

insect agency, but this up to the present has never been systematically attempted. None of these four agencies injure the constitution of the trees ; so that when they are not present, the tree is in a vigorous condition to bear a heavy crop, causes Nos. 3 and 4 may in some cases be of short duration ; if so, it is possible that some of the flowers may escape, or what is more likely some varieties that may not be in flower at that particular time may have escaped. This and possibly some modification due to cause No. 5 may account for the so-called ' average ' crop.

Now to refer in greater detail to these malignant influences.

FACTOR 1.—*Diseases.*

On the whole it may be said that the mango is a singularly healthy tree. No serious fungoid disease is known, and only two kinds of insects may be reckoned as serious in their attacks. The worst of these is undoubtedly the one already mentioned, *Idiocerus* spp. belonging to the family *Jassidæ*, commonly known as Mango Hopper, and in Northern India by the vernacular name of " Chappe."

In Woodrow's Pamphlet on the Mango he refers to this insect as an aphid which " occasionally occurs in such numbers that the tree is weakened and the leaves coated with excretion ; a varnish-like viscid sweet covering like honey-dew. If these aphids be observed early, great benefit may be obtained from a shower of soap-suds having 1 per cent. of kerosene thoroughly mixed with the water." Lefroy in " Indian Insect Pests," writes of them thus :—" Large numbers are found on the mango trees throughout the hot weather, but especially at the flowering season when there is a flow of sap to the flowering shoots. These insects pass through their active life on the tree, sucking the juice of the soft shoots and causing them to wither. The cast skins may be seen in abundance in the under surface of the leaves of the trees. The insects when young, jump actively and when full-grown fly out from the leaves when disturbed. They are rarely plentiful and their increase appears to be assisted by damp winds, such as the east winds of Bihar, which in some seasons blow in February and March. The

result of this increase is seen by the withering of the flowering shoots and consequent failure of the crop.''

Western in Bull: No. 18 of the Department of Agriculture, Philippine Isles, refers to this pest thus :—'' Another serious pest of the mango is the Mango Hopper, the vernacular name for three species of homopterous insects—*Idiocerus atkinsoni*, Leth., *I. clypealis*, Leth, and *I. niveosparsus*, Leth—which some years in certain parts of India are reported to reduce the mango crop to one-third of its normal value. These insects which are found on the mango throughout the year, do not occur as an annual pest, but appear in great number every few years at the flowering season when the principal injury is done. The insect is a small dark wedge-shaped '' hopper '' that jumps or flies short distances. The eggs are apparently laid on the tender flower panicles, where they hatch, and the leaves, as well as the adults, blight the bloom by sucking up the juices that should assist in the formation of the flowers and fruits.'' Lefroy in '' Indian Insect Life '' says, in reference to the family *Jassidæ*: '' Little is known of the life-history; the eggs are, in the known species, laid on the soft tissue of plants; the nymphs are active, found running actively on the plant. The number of moults and details of the metamorphosis are not known for any Indian species; the transformations of *Idiocerus* are wholly passed on the mango tree and the nymphs of other species are commonly seen on their food-plants. *Idiocerus* has a curious cycle, as there is but one brood yearly on mangoes in the early hot weather and the imago (adult) lives over on the tree for the rest of the year. It is possible that this occurs also in many other species, and it is probable that there is a very close inverse relation between the vigour of the host plant and the prosperity of the Jassid species. Hibernation appears to occur usually in the imago stage, but there is very little accurate information on this point. Equally little is known of the parasites or enemies of this family.''

In Leaflet No. 1 of 1912 of the Department of Agriculture, Bombay, it is mentioned that '' this insect is troublesome in certain gardens. It affects the flowers—when the tender fruits drop off

the plants, and it is not uncommon to see small fruits scattered about under trees, indicating the presence of this pest."

Gollan in Government Botanical Gardens, Saharanpur, Report for 1887-8, says :—" I attribute the lightness of the crop to the presence of myriads of the mango-fly (*Idiocerus*) upon the trees while they were in blossom. This insect is found here upon the trees during the whole summer and appears to subsist upon the juices of the leaves, flowers, and of young tender shoots, but it commits most damage when the trees are in blossom, by injuring the reproductive organs of the flowers, and thus causing interference with the setting of the fruit."

It will be seen from the above abstracts that comparatively little is known about this insect. Fortunately they are not of frequent occurrence. There is an interval of eight years in one case and fourteen in another between the attacks.

Mild and cold winters seem to have no particular effect, as in one instance there were sharp frosts shortly before the attacks, and in the other case it was a mild winter. I quite agree with Lefroy that " their increase appears to be assisted by damp winds such as the east winds." It is a common saying amongst the cultivators that if east winds prevail about the time of flowering, look out for " Chappe." At the same time, it should be added, the damp winds would affect the setting of the fruits, as will be explained under cause No. 4, later on.

The immediate effect of these attacks is the dropping of the flowers, leaving the rachis with its main branches quite bare, ultimately to drop off also. I have never seen any ill-effects from their attacks on the foliage. No fungus grows on the fluid they excrete on the foliage, probably for the reason that the ensuing period is too dry for fungi to develop. After the flowering period, these insects seem to disappear. The remedy suggested is spraying with crude oil emulsion. But this must be done before the insect reaches the adult stage. The slightest disturbance when in this stage will cause them to hide themselves in the dense foliage where it is extremely difficult to get at them. They would not be noticed by the ordinary observer until they reached this stage, and as the

spraying of such large trees would be both costly and very difficult, and as these attacks are comparatively rare; it follows that no measures are taken to prevent their attacks. Until we know more about their life-history and particularly what becomes of them in the adult stage, and during the period, which is sometimes of some years in which they are not noticeable; we can do little to combat them.

The other serious insect pest is the mango-fly, *Dacus ferrugineus*, Fabr., of the family *Trypetidæ*.

Lefroy in "Indian Insect Pests" writes about them thus:—"The life-history of fruit flies is generally as follows: the female lays eggs in the tissue of the fruit, piercing the rind by means of the ovipositor, the sting-like continuation of the abdomen. A number of small white eggs are laid, which hatch in a few days to tiny white maggots. The maggots live on the pulp, making tunnels through it and perforating it in all directions. This period lasts about ten days, and the maggot then leaves the fruit, and enters the earth, where it becomes a pupa. From this the fly emerges after the lapse of about a week."

In a letter sent by Gollan on 19th May 1904 to the Entomologist to the Govt. of India, he advises the despatch of a small basket of diseased mango fruit. He adds that "The disease declares itself by hard, apparently sound, green fruits suddenly splitting. Some little time after splitting they turn yellowish and rot and in the rotting pulp whitish maggots are usually found. The disease is of long standing, but this season a greater proportion of fruit than usual is attacked. On some trees quite ten per cent. of the fruit is attacked, on other trees standing close by not a single diseased fruit is to be met with." This was recognised by Lefroy to be the mango-fly.

Gollan's letter is interesting as showing that quite unripe fruit can be so affected as to drop from the trees; and further that some varieties only are affected. My own experience so far is that the disease only affects the late fruiting varieties, particularly that known as Bhaduria, which is our acknowledged latest fruit and would be of good value if it was not liable to be destroyed by the fly.

The factors I am attempting to explain really refer to the setting of the crop and not so much to what happens to it later on. I therefore do not propose to enlarge on this pest now. The same may be said in reference to another insect pest, but which, however, has shown itself so prominent this year as to warrant its being mentioned. I refer to a very large Mealy bug, *Monophlebus* spp. Considerable prominence is given to this possibly serious pest by Stebbing in a letter to "The Pioneer" in December 1902. Every year in April it is to be found on mangoes here, but this year it seriously attacked oranges and other plants indiscriminately. The attacks on the oranges were so bad as to necessitate some action being taken, spraying with Kerosene emulsion helped to keep them down, but the real extermination is done by the hot winds; when these start, a few days are sufficient to see the end of the Mealy bug. They feed on the young shoots and so are a possible factor in lessening crops by weakening the shoots which the following year bear the fruit.

So far then the only serious insect that is likely to materially influence the mango crop is the mango hopper.

FACTOR 2.—*Frost.*

Three failures are attributed to this cause. it is therefore rather an important factor in mango production, as the whole of Northern and Central India is liable to frosts sufficient to damage such trees as mangoes. The ordinary seedling or country variety seems to be much hardier. We hear of the so-called wild mango flourishing even so far north as Rawalpindi. Grafted varieties also vary somewhat in their hardiness.

The question of hardy varieties has of recent years become an important one, in consequence of the attempts to introduce mangoes into almost temperate countries.—California as an example. The question however before us now is not the hardiness of the tree, but the effect of frost and cold on the crop.

It is unfortunate that the information at my disposal says nothing about the actual number of degrees of frost experienced. Only general terms are used, such as 'frost' or 'sharp frosts.'

It is, however, common to get 3 or 4 degrees of frost. Up to 8 degrees may be called sharp frosts, and severe frosts have occurred up to, at least in one instance, 11 degrees. This last, however, was very exceptional. In Northern India the mango rarely commences to flower before the middle of February; by which time frosts are done with. The injury therefore is either to the flower bud or the shoot. Farther south, where the mango flowers earlier, the open flowers are destroyed.

In all cases that have come under my observation, the shoot has been affected, and not the bud alone. These shoots are comparatively succulent and soft. The flowering shoots of a mango are usually produced in late spring and summer, although in favourable seasons young shoots may arise in the rains. In certain instances when the rains have been unusually prolonged, the autumn mild, or winter late in coming in, this latter class of shoots would be more common. These obviously would be immature, or not ripened, compared with the shoots formed in the spring and summer. Luxuriant growth therefore in the rains would mean a large number of soft shoots, which would be more liable to be killed by frosts. Good ripe wood therefore is as necessary for mangoes as it is for many other fruit trees of temperate climes. It is for this reason that a prolonged monsoon is inimical to a good mango season the following year, and that irrigation should be entirely withheld during the autumn and early winter. The best crop of mangoes I ever saw, followed a monsoon that closed completely, fairly early in September. It will be seen that there is some interdependence between the monsoon and any succeeding frosts, as regards its effects on mango crops. Irrigation when frosts are expected, is the only preventive so far attempted. As is well known, evaporation from the water will cause a rise of humidity in the air, which will check, if not prevent, the ravages of a frost of not too great intensity. It would seem as if the best remedy would be in the selection of those varieties that are the hardiest. Unfortunately evidence on this is rather conflicting. The following six varieties are supposed to be the hardiest at Lahore. Alphonso, Bombay, Malda, Sufaida, Darbhanga or Ennurea, and Babu Chandar Nath.

For Saharanpur the following five varieties are said to have withstood 11° of frost the best—Gopal Bhog, Bhadaurea, Langra, Bombay Green and Malda.

In 1911 when there was a good deal of frost, but not severe, I observed the following varieties to have had their tips more or less injured:—Alphonso, Arbuthnot, Bombay, Davie's Favourite, Faizan, Gopal Bhog, Kachamitha. Kistapal, Krishna Bhog, Kutna, Lamba Bhadra, Stalkart. The above list includes some that are supposed to be the hardiest. Alphonso, in Saharanpur, is supposed to be tender, whereas in Lahore it is said to be fairly hardy. Another list of hardy varieties compiled by the staff of the Saharanpur garden, but which I have not yet had the opportunity to test, is the following :—

Bhadaurea, Bombay, Bulbulchashm. Calcutta Amin. Chickna, Faizan, Faquirwala, Gola. Gopal Bhog. Hathijhul, Kachamitha, Kakaria, Kala, Khapariah. Kutna, Lamba Bhadra, Langra, Malda, Najibabadi, Naspati, Nayab. Nucka, Sandurea, Salibunda, Singapuri, Sunder-Shah, Surkha, Stalkart.

It is, however. probable that the situation of the trees had more to do with the selection than the actual variety.

A late Superintendent of the Government Gardens. Nagpur, says in his report, that he was struck with the frost-resisting wild mango plants around Pachmarhi, and proposed getting such as stock, in order to have frost-resistant varieties. It is doubtful if this would have any appreciable effect ; but it is significant that some at least of the wild kinds are frost-resistant. The so-called wild mangoes of the Punjab Hills must be frost-resistant. Maries writes that he saw two types of wild mangoes, one very variable from Kangra, and one from Sikkim. He concludes that the former is the probable progenitor of Western India sorts. and the Sikkim kind the ancestor of the Malda kinds, which, however, have subsequently been intercrossed. It would seem therefore that we must look to those varieties that have a preponderance of the Kangra origin in them, for successful frost-resistant varieties. This, however, is an extremely difficult question, owing to the ancient origin of the majority of the varieties. When we have

successfully hit upon the various typical classes, we may ultimately be able to trace their origin from the two ancestral types. In the meanwhile a general record, as opportunity affords, of those varieties that prove the most hardy, would be an extremely valuable contribution to our knowledge of the mango.

FACTOR 3.—*Heat and dry hot winds at the period of flowering.*

This has been alleged as a cause for the non-setting of fruits by more than one observer. In the Saharanpur Garden Report for 1895-6, Gollan writes :—" I can only attribute the lightness of the current crop to the extreme dryness of the air caused by the prolonged drought having possibly withered up the organs of fructification before the fertilization could be effected." The Lahore Garden Report for 1898 says :—" High winds and a dry atmosphere caused the fruit to drop." Further, for 1900 it says :—" The cold nights and dust storms are the chief causes of a poor mango crop in the Punjab." The Bangalore Garden Report for 1896-7 says :—" The dryness of the soil combined with atmospheric drought, and abnormally high temperature, caused the flower and young fruit to gradually shrivel up." The Lucknow Garden Report for 1892-3 records that " The mango crop was again a light one, owing to the blossom being destroyed by strong dry winds." Drought and the intensely dry condition of the atmosphere is again alleged as the cause for a failure in 1897.

Our own experience is that heat and dryness of the atmosphere are not so fatal unless attended by strong winds. What probably happens, is, that the stigmatic surface is too dry to retain the pollen, which is thus blown away by the winds, so that fertilization cannot take place. Larger groves and wind breaks would greatly alleviate this cause.

FACTOR 4.—*Cloudy weather, excessive humidity, rain, and storms during the flowering period.*

This factor is, I think, almost if not quite the most important and frequent cause of failures. It unfortunately happens that the

mango flowers about the change of the season, at which time storms and some rain are not infrequent.

We hear the same tale from such distant places as Nagpur, Odypore, Lucknow, and Lahore; as well as Saharanpur. The natives attribute such failures either to the east wind or lightning. One observer mentions that after a thunder-storm, the flowers turned black. As rain and cloudy weather at this time come from the east, we can understand the bad name the east wind has; moreover it seems to favour insect attacks. The mechanical effect of storms or heavy rain is easily understood, but it is not so easy to account for the evil influence of cloudy weather and humidity. It is a significant fact, that no matter in what part of India the wild mango is to be found, its flowering period is normally attended with dry weather. The mango is largely if not solely wind fertilized, and dry weather is essential for this. The direct influences of such conditions have never been accurately ascertained. Experiments elsewhere with temperate fruits have proved that pollen is discharged freely only in warm and dry weather. This I believe to be the case with mangoes. In dry weather clouds of pollen can be seen wafting about. Obviously this cannot take place if the pollen is damp. As is well known, only one perfect stamen is developed in a flower, but in a panicle or truss, the staminate flowers largely preponderate. In certain countries, notably in Florida, U. S. A., it has been found that the fruit do not set well. Florida has a rather humid atmosphere, which would probably account for non-setting. Having decided on the cause, the question is how can we remedy these conditions. We cannot control the weather conditions. Such conditions however do not last long, frequently only 2 or 3 days, a week or 10 days would be exceptional. Varieties vary very much in the period during which they remain in flower. From observations made last year it was found that while some varieties remained in flower for 48 days, others again only lasted 9 days. This is reckoning from the first flower to the last flower noticeable of that variety, not necessarily the same tree. There are therefore two ways of escaping the unfavourable weather conditions now under discussion. We

may grow those varieties that are known to remain in flower for a long time, of course not all the flowers would escape, but there would not be a complete loss, or we may grow varieties that flower early and others late, so as to extend the flowering period of the crop generally. I have elsewhere in this Journal (see Vol. VIII, p. 90), gone into the question of mango flowering, so it need not be enlarged upon now.

FACTOR 5.—*Exhaustion following a heavy crop.*

The above is one of the causes given by more than one recorder. We may really call it the law of alternating fruit years. This is so well recognized amongst the cultivators, that it is always taken into consideration when selling the crop, which is usually done before the mango flowers. If this law was the only factor influencing the mango crop, we would no doubt have good years and fair years, in regular alternative succession. This law of alternation is recognized in fruit culture generally, especially in Apples and Pears.

I have elsewhere (see Agric. Journal of India, Vol. VIII, p. 90), partially discussed the important question of alternating fruiting years, but its importance is a sufficient reason for again referring to it in some detail.

Bailey, in his book "The Principles of Pruning," lays down a law that—"Fruit-bearing is determined more by the habitual performance and condition of the plant than by the kind or extent of pruning, it is associated with a quiescent rather than with a stimulated or fitful state, and the habit is more amenable to treatment when the plant is young than when it is old." Under normal conditions it is natural that plants should fruit equally every year. Anything however that disturbs the ordinary equilibrium of the plant's life, would react on the fruit-bearing habit. Some of the factors that may be responsible for such a disturbance have already been discussed. But there are many others, incidental to plant life, that would also have the same effect.

One important factor in this direction is overbearing. Bailey says :—"Overbearing is itself a disturbance of equilibrium, and is almost necessarily followed by a reaction of underbearing. This

corollary has such an important bearing on practice that it should receive careful attention. One extreme follows another, and the oftener these extremes occur the greater is the likelihood that they will become an unremediable or fixed habit of the plant. It is interesting to note that the habit of alternate bearing is most pronounced in plants of long life, suggesting that the habit is largely, if not wholly, the result of the frequent occurrences of overbearing while the plant was young."

Goff, in an article in *American Gardening* on the "Origin and Development of the Apple Blossom," gives some interesting suggestions which may equally be applied to mangoes. He says that leaf and flower buds are in a measure interchangeable. By proper pruning a flower bud may be converted into a leaf bud, and by ringing, a leaf bud may become a flower bud. Flower buds may be 1-2 or many years old before they form flowers. Any restriction of the movement of prepared food in the branches, such as is caused by ringing, or by a wrinkling of the bark formed by the union of the fruit spur with the branch which supports it, tends to the formation of flower buds. Dry weather is also conducive to the formation of flower buds, since during such a period evaporation through the leaves is rapid and the sap becomes concentrated and rich in prepared food. Flower buds are then formed in portions of the tree where there may be no restrictions of the movement of the sap, as at the end of young shoots, etc. Whenever the water-supply is increased the tendency is to wood growth, and the formation of leaf buds. A decrease in water-supply tends to make flower buds. A normal growth is accompanied by a normal formation of flowers. When the fruit spurs of healthy trees push into growth or sap-sprouts start freely from the old wood, growth is abnormal and fruit production is postponed. Investigations show that as active wood and leaf growth ceases, the formation of flower buds begins and may continue until cold weather sets in. During very favourable season for the formation of flowers all the 1-year, 2-year, 3-year old buds, many older buds, and some buds formed during the year, may form embryo flowers. This explains why an excessive fruit crop is always followed by a scanty one.

The above conclusions drawn from investigations on the apple apply equally to the mango. To illustrate the plausibility of the assertion that flower and foliage buds are interchangeable, I have seen cases in the mango which show great irregularity in the differentiation of flower and leaf buds. In some cases, foliage leaves were intermingled with the flower branches of the inflorescence; in others, foliage leaves had developed at the end or apex of the inflorescence. In the latter case although fruit may set, yet it usually does not develop. It would appear that weather conditions have a predominating influence, especially at about the end of the monsoon. The finest year for mangoes that I have seen, followed an early closing of the monsoon. There is therefore some reason in the saying that what is good for a bountiful mango crop is not good for agriculture generally. This has been physiologically explained in the summary of the article by Goff, previously quoted. In the case of trees that are amenable to pruning, the alternating effect of exceptional year, can be controlled, to some degree, by this practice, but in the case of an evergreen like the mango, this is not feasible. The only alternative therefore is the thinning of the crop. What takes place in the mango is similar to that of the apple for instance, only that a terminal shoot takes the place of the spur of the apple. It is simply a question of conservation of the energies of the tree. The demands upon a shoot when bearing a fruit are so great that another fruit bud cannot develop the same year. What follows is, that, immediately after fruiting, some short shoots start from below the fruiting stalk. These are generally in a cluster around the end of the fruiting shoot. They develop more or less, according to the season, during the same year as the shoot flowered. The succeeding year, these shoots, or some of them, develop further and continue growing until checked by the closing of the rains. If dry warm weather follows, these shoots ripen or mature, and flower buds form. If, however, moist weather continues until the cold weather arrives, these shoots still continue to grow, and produce no flower buds; and it is this latter contingency that is to blame for some conspicuous 'failure' years. This particular contingency is probably

beyond our control, but the effects of the law of alternative fruiting years, which no doubt influences all the disturbing factors discussed, can be modified.

1. Thinning the crop is the most obvious method. But to be effective all the fruit—or better, the blossoms from selected shoots—must be removed. This would induce such shoots to start at once into growth with a possible chance of being developed and matured that year.

2. Thinning out the shoots of the growing year, would throw more strength into those left. I have already explained, that at the growing period of a shoot, a number of young shoots are thrown out, below the fruit, it is to these shoots I refer particularly.

3. Some branches remain non-fruiting for some years. It is possible that a judicious heading in of some of these yearly, would induce stronger growth to take place, followed by fruiting the following year. The mango is, as we know, not amenable to much cutting, but can stand a little, and this may be taken advantage of in the way suggested.

4. In the case of large orchards, some trees may be altogether deprived of their flowers. This would induce them to alter their fruiting year; so as to have some trees bearing every year.

5. Lastly, as the whole question is chiefly that of food supply, every endeavour should be made to keep the trees in as healthy a condition as possible. As a rule the mango, after it once begins to bear, gets little or no attention beyond watering. Much has yet to be learnt about providing additional food materials. There is no doubt that good tillage and some judicious manuring would contribute largely towards enabling the exhausted trees to recoup themselves annually instead of biennially, as is now the case. But it should be remembered that although such means as above suggested may change or help to change the alternating fruiting year, yet it is also true that the trees tend to revert to their accustomed habit, and it is probable that this reversion is the more rapid and the more complete the older the tree, and the more indifferent the general treatment of it.

THE SUPPLY OF MILK TO INDIAN CITIES*

BY

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The supply of milk to Indian cities is known to be at present in a very unsatisfactory condition. Whether looked at from the point of view of the healthiness of the milk obtainable, or of the quality of the milk to be had, or of the quantity available,—it is open to the most strenuous criticism. There is *no* control at present whatever in most cities,—except possibly the Presidency towns and one or two others. The Act for the prevention of adulteration (Act II of 1899) in Bombay is a dead letter. And as a result of these things, the condition must be recognised as unsatisfactory from every point of view. This would be inexcusable except for one fact which increases the difficulty of dealing with the problem. The cost of milk is already very high: anything which would increase the price, even though it made the supply a better one, would but increase the difficulty of getting it to those people of the poorer classes who are at present suffering most from the present conditions. At every point, in every proposed method of dealing with the matter, one is met by the difficulty of controlling, of improving the supply without increasing the cost,—for, and I repeat it, if a remedy involved a material increase in the cost, it would be perhaps worse than the disease.

To show exactly where we stand, it would perhaps be best to give a description, obtained from data collected, many of them specially for this paper, of the present supply of a city, namely, Poona. It is typical of many other places: the difficulties which surround the problem here are those which are found elsewhere: and it is probable that a thorough appreciation of the present position may at once lead to a clearer understanding of the methods which are feasible to improve the situation.

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* A paper read at the Provincial Agricultural Conference held at Poona in September 1918.

Poona City contains, according to the last census, a population of 1,17,256. Its population is a fairly representative one, save that perhaps the so-called higher classes are in slightly greater numbers than usual. There is a limited amount of manufacturing industry, but Poona cannot be called a factory town. It lies in a district which is dry, almost semi-arid, except where irrigation occurs,—but both above and below the city there is a large area watered and irrigated by the Mutha Canal extending from eight to ten miles above the city to fifteen miles below. Irrigation from wells is frequent in the country round,—and that this country is adapted to the production of fodder is seen by the train loads of lucerne which are sent to Bombay every day for feeding horses.

The city like all others is partly supplied from milk animals kept in the city, and partly from milk brought in from outside. I will deal with the latter source of supply first, and am able to give figures obtained from an actual census of the amount brought on two days into the city boundaries. There are fifteen entrances to the town, and the milk is brought from no less than forty-seven villages.

The actual supply brought in, in one day amounted to 5,560 pounds, almost all of which was brought in by hand and, in a few cases, by bullock cart. The train was only used for the milk from three villages,—and the amount brought only amounted to 120 pounds. For the remainder the milk came as follows :—

From villages three miles or less from the centre of Poona.	1,168 pounds or 21 per cent. of the total.
From villages from three to six miles from the centre of Poona.	2,688 pounds or 48·3 per cent. of the total.
From villages from six to nine miles from the centre of Poona.	1,582 pounds or 28·5 per cent. of the total.
From villages over nine miles from the centre of Poona (by train).	120 pounds or 2·2 per cent. of the total.

It will be seen, therefore, from how restricted an area Poona City draws its milk supply. It is practically all brought in from

the immediate neighbourhood, the railway is not used to any appreciable extent, and the means of bringing it are of the crudest.

As already stated, it is usually brought by hand and generally in brass pots slung over the shoulders of the milkmen, or carried on their heads. The number of people engaged in this work, and for many of them it must mean the loss of at least half a day, is 351, and the average amount brought per man is only sixteen pounds. It is evident, therefore, that this portion of the Poona City supply is brought and distributed in an exceedingly uneconomical manner, and involves a very large waste of labour without any corresponding advantage.

But what of the price and quality of the milk thus brought into a city like Poona ? In the first place, by far the largest amount is buffaloes' milk. Out of the animals supplying the milk, in number 956, only 178 were cows,—and taking the yield of a cow in the Deccan at five pounds and of a buffalo at ten pounds of milk per day, this would indicate that only $8\frac{1}{2}$ per cent. of the milk brought into the City is provided by cows, and the remainder by buffaloes. This indicates the extent to which even in the Deccan, the buffalo proves itself *the* milking animal of India.

Bought at the entrances to the City, the price varies with the quality. The results of all my previous investigations would indicate that for such cows as occur in the Deccan, all genuine cows' milk contains at least $3\frac{1}{2}$ per cent. of fat and $8\frac{1}{2}$ per cent. of other solid matters ("Solids-not-fat"), while the corresponding figures for buffaloes' milk are 5 per cent. of fat and 9 per cent. of other solid matter. These figures are, in fact, exceptionally low, and ninety per cent. of actual genuine samples will be far richer than these figures show. In determining the number of adulterated samples, I have allowed all samples to be genuine which, even on this basis, showed less than ten per cent. of water added. On this basis, out of fifty-one samples collected at the entrance to the City, only ten were genuine or less than twenty per cent., the remainder were adulterated with more than ten per cent. of water. The amount of adulteration varied with the price charged here, as well

(as we shall see later on) as in samples bought at shops in Poona City. Of samples bought

(1) at 4 seers (8 pounds) per rupee, all were genuine;
(2) at 5 seers (10 pounds) per rupee, sixty-four per cent. were adulterated with water, and the average amount of water added was *twenty-nine parts* to 100 parts of genuine milk;
(3) at 6 to 7 seers (12 to 14 pounds) per rupee, fifty per cent. were adulterated with water, and the average amount of water added was *forty-seven parts* to 100 parts of genuine milk;
(4) at 8 to 9 seers (16 to 18 pounds) per rupee, ninety-two per cent. of samples were adulterated with water, and the average amount of water added was *seventy-two parts* to 100 parts of genuine milk.
(5) at 10 seers (20 pounds) or more per rupee, all the samples were adulterated with water, and the average amount of water added was *one hundred and seventeen parts* to 100 parts of genuine milk.

Thus the close connection even before the milk reaches the City between the price and the amount of water added is evident,—and the fact of the almost general adulteration of samples now brought from oustside seems proved.

We are in fact able to conclude that at present, in so far as Poona is a typical city, that

(1) the milk brought from surrounding villages for City consumption is almost all brought in small quantities and carried by hand,
(2) this milk is adulterated with water in the case of practically eighty per cent. of what enters the City,
(3) the amount of water added varies very closely with the price at which the milk is to be sold,—and there is not even an even chance of getting pure milk if more than six seers (12 pounds) of milk are obtained per rupee, while the cheaper milk contains already more than its own volume of water. This is at the entrance

to the City, before the retailers' profits are added and the retailers' adulteration occurs.

In one matter I have been rather pleased with the condition of the milk,—namely, in the amount of dirt it contains. This is not nearly so great as would have been expected, and does not show the addition of quantities of dirty water. I have divided the milks into four classes. and the results of examination of fifty-one samples are as follows, the dirt being determined by 'Gerber's dirt tester':—

Clean, or nearly clean samples	...	56·7	per cent.
Fairly clean samples	..	33·3	,,
Distinctly dirty samples	...	7·8	,,
Very dirty samples ...	...	1·9	,,

But, after all, the milk brought into Poona City only forms a portion, and not a very large proportion, of the milk consumed there. A much larger quantity is obtained from animals maintained in the City itself. and for information with respect to this, I am indebted to a census of cattle taken by the City Health Department some time ago,—as well as to inquiries by my own assistants.

According to this census there were *2,688* milking animals kept inside the City. of which *1,532* or 57 per cent. were kept for private use only. and *1,156* or 43 per cent. kept for sale of the milk. I do not propose to refer further to the former class, except to note that among these animals kept for private use by far the larger proportion were cows and not buffaloes,—these amounting to 73·5 per cent. of the total number so kept. This probably arises from the fact that a cow is much more easy to attend to than a buffalo, and can usually be tended by a member of the household. A buffalo, on the other hand, requires a servant, as not only is its feeding more troublesome but it has to be taken out every day, and requires far more thorough washing. But it seems nevertheless, from the preference for it by milk-sellers, that the buffalo is found to be a more profitable milking animal.

Among the animals kept for the sale of their milk (*1,156*) 224 or 19·75 per cent. were cows, and 932 or 80·25 per cent. were buffaloes.

The sheds in which they were kept were distributed all over the city, and were mostly very small. Over eighty per cent. of these sheds had less than ten animals, and over fifty-five per cent. had less than five animals. They were situated in all sorts of positions, without any control. Nearly six per cent. were under a dwelling house: over six per cent. were either *in* a dwelling house or on the verandah of a dwelling house: over fifteen per cent. were attached to and continuous with a dwelling house, while sixty-three per cent. were in the compound of a dwelling house. Though the pavement of the milk sheds was good (being made of stone) in thirty-seven per cent. of cases, yet the remainder were very bad. No pavement whatever existed in over thirty-two per cent. of sheds, and in sixteen per cent. it was so bad that it might as well have not been present. So far as these two classes of sheds are concerned, they are abominably insanitary, the urine sinks into the ground and remains there. The sheds, too, are overcrowded. Allowing six feet as the necessary length for an animal to stand, the width allowed in the shed for each animal is only 3⅓ feet in three per cent. of cases, less than five feet in 14 per cent. of sheds, and less than 6½ feet in twenty-three per cent. further of the sheds.

The milk produced by these animals can only be estimated, but taking the same rate of production as has previously been suggested (5 pounds per cow and 10 pounds per buffalo per day) the amount available from animals kept in the City will be

Private sheds.

Cows	(1,126 at 5 pounds)	... 5,630 pounds
Buffaloes	(406 at 10 pounds)	... 1,060 pounds
		9,690 pounds

Sheds for sale.

Cows	(224 at 5 pounds)	... 1,120 pounds
Buffaloes	(932 at 10 pounds)	... 9,320 pounds
		10,440 pounds

This gives a chance of estimating the total daily supply required by a city of the size of Poona, and if the above figures be added to those of the milk brought in from outside, the amount comes to 25,690 pounds; of this 21·25 per cent. is obtained from outside

sources, *37·72* per cent. from animals kept by house-holders for their own use, and *40·63* per cent. from animals kept by *gowalas* in the City for the sale of the milk. This gives an idea of the problem which is before anyone who wishes to improve the milk supply of a large Indian city.

We have now to consider the organisation for the sale of milk. There is one regular milk market (Jogeshwari) where all outsiders who bring milk for general sale, are found, and where retailers congregate to purchase this supply. By the time it is exposed for sale here the milk has become dearer, and has also become more adulterated. We purchased only ten samples here, but they were obtained in several days, at prices varying from four to nine seers per rupee.

(1) One sample was bought at 4 seers per rupee and was genuine.

(2) Three samples were bought at 5 seers per rupee : two of these had water added, the average amount *being sixteen per cent. of the original milk.*

(3) Three samples were bought at six and seven seers per rupee : all were adulterated, and on the average the milk as sold consisted at least *to the extent of one-half of added water.*

(4) Three samples were bought at eight and nine seers per rupee : all were adulterated, and on the average the milk as sold contained *135 parts of water for every 100 parts of original milk.*

The chance of adulteration, therefore, and the quantity of water added varies almost exactly with the price,—and even at the wholesale milk bazar in the city, if more than 4 seers (8 lbs.) of milk are obtained per rupee, there is an almost absolute certainty that pure milk will not be obtained.

When we come to the milk as retailed in the shops in Poona City, the state of things is still worse. Here, even if the very high price of four seers per rupee* is paid there is no certainty of getting

* It may interest those acquainted with the milk trade in England to note that 4 seers per rupee is equivalent to nearly 2½d. per pint.

pure milk. Even at this price out of nine samples obtained only six could be passed as pure even with the exceedingly low standard we are setting up. Of the others, thirteen parts of water were added on the average for 100 parts of milk. If the price is lower, the adulteration becomes a certainty. At 6 to 7 seers per rupee, there is, on the average, 47 parts of added water for every 100 parts of genuine milk; and at 8 seers per rupee, there is no less than 92 parts of added water for every 100 parts of the original milk.

I am able to get an idea as to whether the condition of things is getting worse or no by comparing these results with those obtained by one of my assistants (Mr. S. R. Paranjpye) in Poona city in 1911. He then found the results indicated in the following table :—

	Price 4 seers per rupee	Price 5 seers per rupee.	Price 6—7 seers per rupee.	Price 8 seers per rupee.
Number of samples taken	1	2	5	18
Genuine samples	1	0	2	2
Adulterated samples .. .	0	2	3	16
Water added for 100 parts of pure milk		23 parts	19 parts	37 parts

It would seem evident that while adulteration is no more general than two years ago, yet it is more shameless, and the quantity of water added for milk of the same price is much more than it was previously. In other words, *pure* milk *is* rising in price very rapidly, and the probability of getting pure milk at any particular price is getting less.

I may now summarise my conclusions with regard to the present condition of the milk supply of Indian cities, so far as they are illustrated by experience in Poona, considered as a typical city.

(1) The milk supply is partly (to the extent of about one-fifth) brought from the outside of the city. This amount is drawn from the immediate neighbourhood and is almost all brought in by hand in small quantities.

(2) The remainder is produced inside the city,—partly by animals kept in or in connection with houses for private use only,—and partly by animals kept for the most part in unsatisfactory and insanitary small sheds.

(3) Except for the animals kept for private use, about ninety per cent. of the milk is produced from buffaloes.

(4) The milk as it enters the city from outside is already very largely adulterated with water,—the adulteration varying with the price. No milk costing less than 4 seers per rupee can be expected to be pure.

(5) The milk as obtainable in the city itself is adulterated to a still greater extent. Again no milk bought at a lower price than 4 seers per rupee is likely to be pure,—while it is practically certain that all milk costing 6 seers per rupee or less will be adulterated.

(6) The practice of adulteration is increasing in shamelessness, the amount of water added is greater and greater,—as the price of pure milk tends to rise.

(7) The dirt in the milk is not so great as would be expected from the insanitary and dirty conditions under which the milk is produced.

Such being the conditions of the milk supply at present in Poona,—and there is no reason to suppose that the conditions would be materially different in other big cities,—the question at once arises as to what can be done to deal with the situation both as a piece of sanitary improvement, and as an agricultural problem.

From a sanitary point of view what we want to do is to ensure—

(1) That the cattle—cows or buffaloes—giving milk are healthy. Of this there is no control whatever at present.

(2) That they are kept under sanitary conditions. For the animals inside the city I have shown that this

is not the case now, and there is every evidence that the conditions in the villages from which the milk comes are no better, except for the fact that there is plenty of fresh air.

(3) That the milk should be in good condition when delivered to the customers. The milk is delivered only once a day, and hence has to be kept without pasteurisation or other method of preserving, in a hot climate for many hours.

(4) That the milk should not be mixed with water or creamed before sale.

(5) That the arrangements for bringing to market should be such as to prevent the milk becoming dirty, or liable to be infected with objectionable materials.

This represents only one side of the question. From an agricultural point of view we want to find out the most economical method of meeting the large demand for milk from our cities, and placing it at their disposal at the cheapest rate possible. Once more I would state that in my opinion the question of price is vital. Any attempt to impose sanitary measures which will result in a rise in price of pure milk will be a mistake, and the problem is to find a method of so economising in the production of milk, and in the method of its conveyance to market, that it will be possible to impose restrictions in the interests of sanitation without raising the price.

Is this possible? I think it is, judging by the experience of the last few years here, and by the experience of almost all other countries in which the dairy industry is highly developed. I shall not be able, in this short account which follows, to give all the reasons for the positions I put forward, but the evidence is available.

In my mind, three things are radically wrong with the present milk supply, as illustrated by Poona, and which lead to the production of a very bad supply at a very high price :—

(1) The animals which are used for milk supply are subject to defects both in the case of cows and buffaloes.

In the case of cows, they are not produced for milk, but are in most cases incidental in the production of a breed of working cattle. In the case of buffaloes, though they are primarily produced for milk purposes, the number of really good milking animals or milking strains is decreasing,—and such animals are not obtainable now at all easily. In other words, the amount of milk produced by the animals used is very small for the amount of food consumed.

(2) The animals are kept, in large proportion, where they ought not to be kept, namely, inside a big city. They are there, in very expensive quarters under almost necessary insanitary conditions, where all the food has to be carried to them,—where it is in many cases necessary, for economy's sake, to slaughter them when they become dry—simply because of the difficulty hitherto felt of carrying milk in good condition from any considerable distance. This difficulty can be got over, and, if this is true, milk can be delivered in Poona, as in most other large cities from animals kept outside, more cheaply and under purer conditions than by the present arrangements. It seems to me essential to take the cattle out of the cities,—and to arrange to transport milk.

(3) The milk already produced outside is transported to the cities in the crudest, the most expensive and almost the most insanitary manner possible. If the bringing of the milk from villages to the cities can be organised, it can be cheapened, more can be produced by the same people who are now producing it, and better milk will be available in the city.

It seems therefore of vital importance, if the milk supply is to be improved:

(1) that the animals should be improved so as to give a larger amount of milk for the food employed;

(2) that the animals should be in cheap and natural surroundings outside the city instead of inside ;

(3) that the transport of milk both from adjacent points by road, and from distant points by railway, should be organised, so that cheaply produced milk should be delivered in the cities in good condition.

With regard to the first of these points, namely, the production and use of a better animal, the difficulties are perhaps greatest, and will take long to solve. For the present, all a dairy owner can do is to take the best breed available, whether of buffaloes or cows, and the best animals among them with the best of male animals for the herd, and ensure that the best is got out of these animals by suitable feeding.

In connection with the development of better animals than are in use at present, my colleague, Mr. J. B. Knight, who has had large experience, has recently expressed himself as follows :—

"The development of a profitable dairy animal from any of the types existing, without outside blood, is the work of generations, working on scientific principles, consistently, intelligently and persistently. The agency for effecting this is difficult to point out. The necessity for continuity in this work is so great that it places it beyond the scope of Government Institutions, because of the necessary frequent changes of personality. The only agency which could undertake this work, with a reasonable expectation of accomplishing marked results does not evince any great interest in work of this character. We refer to the hereditary Chiefs and Sardars, who have estates adapted to the work, and who, if they were really in earnest, could carry on this work from father to son, along fixed lines and accomplish something. If the above noted gentlemen could be aroused to form breeders' associations and definite ideals laid down, and authentic records of breeding and production kept, some noticeable improvement might begin to appear in ten or fifteen years."

Till such time as this is done it will be a question of utilising the best of the existing milk breeds and milk animals. That even

among existing breeds there are very great differences is shown by the following figures from the records given me by Mr. Knight:—

Breed of Animals.	Average yield of milk per annum, in lbs.	Average yield of best animals, in lbs.	Maximum yield per annum, in lbs.
Sind Cows	about 2,000	about 3,500	4,700
Kankrej Cows (Gujarat) .	about 2,000	about 3,500	4,265
Gir Cows ...	about 2,000		3,687
Jafferabadi Buffaloes (Poona records) ..		5,500	5,438
Delhi Buffaloes ..	3,000		6,000 to 8,000
Surti Buffaloes ...	2,780		5,034

The Deccan breeds of both cows and buffaloes give a much less quantity than this per annum.

The question of getting the largest amount of milk from animals kept is largely connected with suitable and regular feeding. Such feeding is very rarely done at present. There is hardly ever any arrangement for the regular growing of succulent fodder, and for its provision in the form of silage during the drier seasons of the year. Without this the best will never be obtained from the cattle kept,—and the milk supply, if it is to be in the greatest quantity and best quality that the animals can produce, must be obtained from a situation where this regular feeding is possible, where growing and storage of succulent fodder can be made, and where the animals can utilise it best in the production of milk. If we look on the animals, as we ought to do, as simply milk-making machines —the cost of the fodder for each pound of milk produced becomes the vital consideration in the economic success of milk production. At present I am convinced that the production is not economic,— because animals are used giving very little milk, and the feeding is not such as to lead to their giving the maximum amount of milk.

Again, the animals should be in cheap and natural surroundings away from the city. I would do everything to encourage the growth of country dairies or of the keeping of cattle, for milk supply to towns, in villages,—and everything to discourage the keeping of

cattle for commercial milk production in the city, at least when a satisfactory supply from outside is arranged for. I think that the provision of municipal sheds for milk cattle, and all such arrangements, while they may be necessary in certain cases at present to ensure sanitary milk at all, are essentially a move in the wrong direction. The object should be to get the cattle removed away from the city entirely, and transport the milk.

For villages or, in fact, for centres of milk production either near or far, the chief question seems to be the organisation of the supply either by large dairies, or by co-operative arrangements for collecting and transporting the milk.

There has been much talk in the last two or three years about the organisation of large dairy companies for the supply of cities. Such large dairies are likely to be successful if located suitably on cheap land with regular water supply,—with good railway (or road, if near enough) connection to the market,—and if good animals are kept. As an illustration of what can be done in this direction, I may note that the Military Dairy in Kirkee can now and does now place milk in Bombay at a cost of 2 annas per pound. This is of course done because it is a large concern with well selected animals with excellent feeding arrangements, including the regular use of silage when green grass is not available, and with pasteurising and cooling arrangements to ensure that no milk goes bad. With the perfecting of pasteurising, there is no need for such a dairy to be near the city supply, provided there is a good railway connection; it can be located wherever, say, within a hundred miles, milk production will be the cheapest and most successful.

Apart from the establishment of large dairies as just suggested, the only method of ensuring a pure milk supply at a cheap rate, is the organisation of village production and transport. It always seems to me,—and it really is,—a great pity that such a large amount of labour should be employed in merely taking milk to market, which could be used in tending more animals and producing more and cheaper milk. The whole is a matter of gaining the confidence of the village cow-keepers, and then their organisation. The winning of their confidence is a thing for which no

rules can be laid down, but it is an essential preliminary to the organisation of the supply,—either by a middleman who buys it in the village, or better by a co-operative organisation of the milkmen themselves.

I only know one such co-operative organisation in India at present,—at Benares,—and the account of this (which I owe to Mr. Ewbank, Registrar of Co-operative Societies) illustrates its possibilities and also its difficulties. I will quote the account of this by the Registrar of Co-operative Societies, United Provinces, and then give a summary of its accounts for the last half year of 1912. In this account an "Ahir" is simply a cow owner.

"The Vishweshwar Co-operative Dairy at Benares is an institution started and owned by Ahirs and not by capitalists. To remove at least partially the great complaint about the impure milk supply of the town, the idea of starting a dairy to supply pure and fresh milk was suggested to the Ahirs and some of them took it up. They organised the business with the help of Babu Shiva Mohan Lal, Inspector of Co-operative Societies. A manager was appointed to work under the guidance of a committee of Ahirs who elected Babu Motichand, a leading resident of Benares, as their President.

"The Society was registered in June 1911. The shareholders are almost exclusively the Ahirs and they have paid Rs. 354 in shares so far. They will continue to buy shares from their savings. No other capital is employed if we exclude the cash credit of Rs. 100 which the Benares Bank has sanctioned and the amount borrowed to build sheds. Sales are made for cash and the sale proceeds are enough to meet current expenditure and leave a margin for profit. The manager keeps the accounts. There is also a credit branch for advance of loans to the Ahirs.

"That dairy management purchases milk from the individual shareholders (the Ahirs) at ten seers for a rupee. The feeding of cattle and the milking is conducted in the presence of the manager, the headman of the Ahirs, and some servants. The milk is collected in cans, locked up by the manager and carted to the city in charge of the salesmen. The cans have pipes attached to them the contents can be taken out, but nothing can be poured in. One

horse cart and one *ekka* are at present employed for cartage. They take the milk morning and evening to the five shops which have been opened in the various quarters of the city and the milk is sold there to the general public. The rate is eight seers a rupee. Shops have been taken on rent and one salesman works at each shop. The manager goes out from time to time to see how they work and to attend to complaints. There is a great demand for the milk. The crowd at the shops is sometimes as large as at the third class booking offices in large railway stations.

"The dairy is situated outside Municipal limits, about four miles from the centre of the city. A plot of land was taken in the beginning on lease and is still in occupation. An opposition set in soon after on behalf of vested interests; the other Ahirs and professional dealers left no stone unturned to discredit the organisation and to injure it. They spoke to the owners of the shops to eject the salesman, and also to the landholder and his agents not to allow any more land to the dairy. Shops had to be changed or rents raised and the servants of the landholders had to be propitiated. On one or two occasions some Ahirs armed with lathis came to threaten the salesmen at the shops. The landholder and his tenants raised difficulties when they were approached to give some more land for extensions. In this matter the aid of the district authorities was sought through the Registrar of Co-operative Societies and they settled reasonable terms with the landholder and the occupancy tenants. One tenant is still objecting. This is about the only matter in which help has been given by the authorities. No help has been given by the Municipality.

"The success of the dairy was soon noticed. People thought there was a good deal of profit and hardly two months were out when a rival shop was opened in the immediate vicinity. In this case some men combined to buy milk from the Ahirs in the city and put them in cans similar to those of the dairy, rented a shop adjoining the dairy shop and brought the milk there for sale. As they had not to traverse any distance they often managed to reach their shop earlier and customers who did not like to wait bought from them. They had also a comparatively small quantity

to sell. The rival shop is now on the decline. A capitalist however who had his dairy at Calcutta and who could not make it a success there is shifting to Benares and some of his cattle have already come.

"The management has found from experience that there is not much profit in this business if it is run on modern lines, but that it can pay its way. In Benares specially even well-to-do people are not willing to pay a little extra price for good and pure milk. The dairy has three ponies and it had to pay on account of their feed, treatment, occasional breakdown and hired labour, Rs. 900 during the last year for transport. There were also occasional surpluses of milk which resulted in loss. *Dahi* or butter is generally made of the unsold milk, but they yield much less profit than milk. The surplus is occasional, so it will not pay to engage a permanent establishment to deal with it. An attempt was made to sell the extra milk to sweetmeat-makers at a slightly reduced rate, but they are somehow in opposition and are determined not to give any help.

"It has also been found that the best customers are the common people who buy for cash and give no trouble. Formerly the manager made it a point to supply to public institutions and rich men, but delays, deferred payments, the question of commission to servants, etc., came in the way and he has now definitely given up the practice. The manager has also hitherto failed to solve the question of a house-to-house supply, for Benares is peopled mostly in lanes through which no carts can pass. A sufficient number of customers living in one locality has also not come forward to pay the extra cost of labour.

"The dairy has about 100 head of cattle of which about 30 are dry. There are more buffaloes than cows. The outturn of milk now is nine maunds per day, but the quantity goes down in the summer."

Of course this is only a small concern: there are some groups of villages near Poona, for instance, where a larger society could probably be organised than that of which I have spoken. This Benares Society works, however, on a very narrow margin of profit.

Its accounts for July to December 1912 showed a gross profit on the sale of 120,700 pounds of milk, of Rs. 1,595 and the net profit was Rs. 235.

Perhaps this is not a *brilliant* success,—but it sells pure milk at 8 seers per rupee in Benares, a price at which pure milk is *never* obtainable in Poona.

This organisation of milk production away from the cities, and of transport to the cities does not seem beyond possibility in Western India, whether by large dairies, or by the utilisation of village supply. Exactly the mechanism for doing it will have to be worked out. Neither the data nor the means are available for giving details of such a mechanism. But every evidence exists to show that it can be done.

When it is done, then the time will have come to apply strictly sanitary rules with regard to the milk cattle-sheds inside the city, to the quality of milk sold in the streets or in the shops, and generally to bring the milk supply under the sanitary control which is so very essential. Till such organisation has been shown to be workable, without raising the price of milk, then I fear that the supply as at present arranged cannot be interfered with. It is a great pity that this is the case, but anything which tends to raise the present very high price still further would defeat its own object.

In conclusion, I have tried to show the deplorable condition of city milk supply at present in Western India, the difficulties in improving it, and the methods which seem to offer the most hopes of success. The position is by no means hopeless, but it is difficult. The data I have put forward will, however, I hope, lead to a wide discussion of the subject, and to the improvement of one of the very worst conditions in city life in Western India at present.

THE ESTABLISHMENT OF COTTON MARKETS IN EGYPT*

BY

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Lord Kitchener has done much for agriculture in Egypt, but one of the most useful measures for the benefit of the cultivator which he has introduced is the establishment of cotton markets. This paper gives a brief account of the management of these markets with a view to induce Municipalities and District Local Boards in this Presidency to follow the example of Egypt. The control and financing of the markets is in the hands of Municipal or Provincial Councils according to their location. The market consists of a space of about one acre enclosed by a wooden fence which costs about Rs. 770 to make. Within it a wooden shed with two or three compartments is erected to accommodate the market superintendent or other employees; this costs from Rs. 310 to 460. In the centre of the market stands the official weighing machine with post and cover complete, costing about Rs. 150, and by its side is a shed about 60 feet long by 35 feet wide, for protection against sun and rain. In a conspicuous position near the entrance and facing inwards is erected a large signboard on which is marked up daily with large enamelled tin figures, like those used for the score at a cricket match, the opening price of cotton on the Alexandria Exchange together with the previous day's price for purposes of comparison. Should the price rise or fall more than about 12 annas in the course of the morning a further telegram is sent from Alexandria and posted up in a separate line, thus :—

....................Yesterday's price of cotton.

....................To-day's opening price of cotton.

....................Alterations in price.

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* A paper read at the Provincial Agricultural Conference held at Poona, September 1913.

The prices are official and the Telegraph Department render a monthly account for the telegrams.

Besides, a circular is despatched every afternoon from the head-quarters of the National Bank, giving the day's prices for every grade of cotton, cotton seed and of contracts. For this the Bank is paid Rs. 92-4-0 a month by Government. In this way the cultivator has accurate information as to the latest prices and is not dependent on the buyer who is often unscrupulous.

The staff is composed of :—

A market Superintendent on from about Rs. 75 to 95 a month for 6 months.

A doorkeeper on about Rs. 46 a month for 6 months.

One watchman on about Rs. 17 a month for 6 months.

One watchman on about Rs. 17 a month for 12 months.

At markets receiving about 30,000 lbs. of cotton a day an official weigher on about Rs. 62 a month for 6 months is engaged: at smaller markets the superintendent acts as weigher. The cultivator can have his cotton weighed direct on the official machine or verify weights recorded by public weighers, who are allowed to charge from $2\frac{1}{4}$ to $4\frac{1}{2}$ annas and work in the market. In addition to public weighers, cotton experts are allowed to work in the market. The entrance fees charged are $1\frac{1}{4}$ annas a cantar = practically 100 lbs. and $\frac{1}{2}$ anna for every additional half cantar, and no charge is made for weighing on the official machine. The money is collected at the door by the doorkeeper, who judges by the size of the sack what fees to collect, as nearly all cotton is brought in large sacks weighing about $1\frac{1}{2}$ cantars. A demurrage charge is levied in busy markets for cotton left there, at the rate of half an anna for 24 hours in the case of merchants after purchase or for 48 hours after entrance in the case of the cultivator.

Small stores and offices are erected in many markets for the use of merchants. They are not allowed to project more than 23 feet from the fence along which they are built. The Council either erects the stores, and charges about Rs. 154 for the season for each one measuring 23 × 16 feet, or lets the space at from $6\frac{3}{4}$ annas to Re. 1-$6\frac{1}{2}$ per area of $10\frac{1}{2}$ square feet.

Some of the markets are being used for distribution of cotton seed on behalf of the Agricultural Department and a commission of 6¾ annas per 5½ bushels is paid to the Council. The Khedivial Agricultural Society use the markets as agents for the sale of their chemical manures, for which the Council gets a commission of about 5 annas 8 pies on every bag sold.

An inquiry has been made recently by the Department in many of the cotton centres of this Presidency as to the system by which the cultivators market their cotton and it has been found to be most unsatisfactory. The crop is either sold before it is picked, generally to great disadvantage, or it is brought to *bunyas* in the bazaar with or without the intervention of a middle-man. The weighments are reported to be dishonestly made in many cases, and owing to his ignorance and illiteracy the cultivator is deceived as to the real market rates. The laxity allowed in the use of weights and measures in India and the consequent loophole for all kinds of trickery have been a source of amazement to me, ever since I investigated the subject many years ago, and I am astonished that the agricultural community have endured these abuses so long. The only district where any attempt has been made to stop them is, as far as I am aware, East Khandesh.

I have appended an estimate of the capital expenditure, annual maintenance charges, and income derivable from the establishment of a cotton market in a town where the daily delivery for 5 months may be expected to be 50,000 lbs. per diem. I have estimated the charge for entrance into the market at a quarter of that levied in Egypt, but the profit would be very fair.

Estimate of Expenditure and income for Establishment of a Cotton Market.

DETAILS.		AMOUNT. Rs. A. P.
Capital Expenditure.		3,800 0 0
Barbed wire fencing for one acre	Rs. 150 0 0	
Shed with three compartments, brick, 16′ × 12′	„ 900 0 0	
Weighing Machine	„ 150 0 0	
Shelter, 60′ × 35′	„ 600 0 0	
Construction of godowns with two compartments 20′ × 25′	„ 2,000 0 0	
	„ 3,800 0 0	

Details.			Amount.
			Rs. A. P.
Annual Expenditure.		..	946 0 0
(*a*)			
Depreciation on building @ 2 per cent.	.. Rs.	76 0 0	
Interest on capital @ 4 per cent.	.. "	152 0 0	
	"	228 0 0	
(*b*) *Staff.*			
Superintendent on Rs. 40 for five months	.. Rs.	200 0 0	
Door-keeper on Rs. 15 for do.	.. "	75 0 0	
Watchman on Rs. 12 for do.	.. "	60 0 0	
Watchman on Rs. 9 for 12 months	.. "	108 0 0	
Weigher on Rs. 30 for five months	.. "	150 0 0	
	..	593 0 0	
(*c*) *Contingencies.*			
Telegram charges at 8 annas a day for 150 days	.. Rs.	75 0 0	
Miscellaneous	.. ..	50 0 0	
	"	125 0 0	
	Grand Total	..	4,746 0 0
Estimated Income.			
For markets dealing with 50,000 lbs. per day.			
Charge at ¼ anna per 100 lbs.		..	1,172 0 0
Rent of godowns		..	300 0 0
	Total	..	1,472 0 0
	Net profit	..	526 0 0

GREEN MANURING ON TEA ESTATES

BY

CLAUD BALD,

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THE question of manuring is now receiving a good deal of attention on many tea estates in North India, and if labour should by any means become more plentiful than at present, the use of manures is sure to be very largely extended. The only consideration which hinders many managers from expanding in this direction is that the labour at present available is hardly sufficient to maintain proper cultivation under ordinary circumstances without the addition of the special staff necessary, not only for application of manures, but also for dealing with the increased growth of weeds, which is the first result of any manurial application. Green Manuring is a branch of the subject which deserves very special consideration; because it is much cheaper than artificial or chemical manures, it takes less labour for a given result, and it is more permanent in its results. It is slower in its effects than a complete chemical manure; but it is safer, in that it does not provide an artificial stimulus, which tends in some instances to soil deterioration.

The Scientific Department of the Indian Tea Association has from time to time invited attention to this subject, by the issue of pamphlets and papers on green manuring. Dr. H. H. Mann wrote a particularly useful monograph in this connection in 1906, and in the same year he wrote a very informing article in the *Agricultural Journal of India*, Vol. I, Pt. 2, in which special reference was made to green manuring.

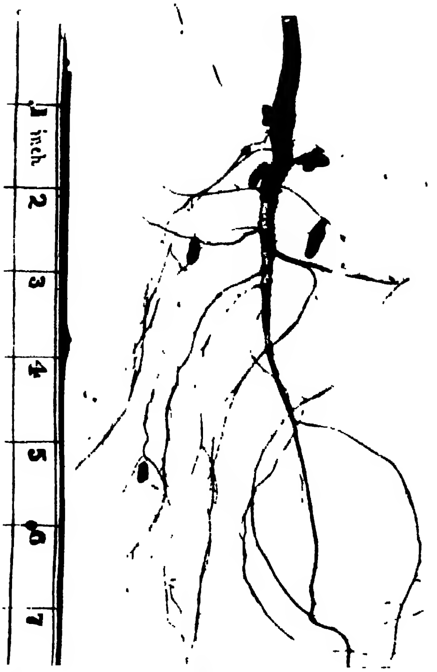

Fig. 1.

Fig. 2.

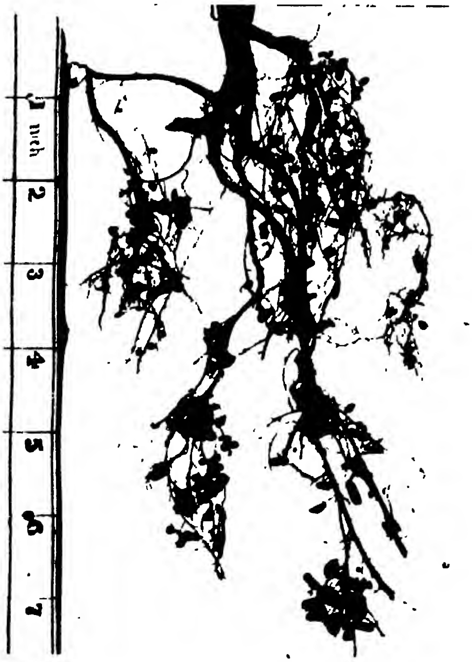

Fig. 3.

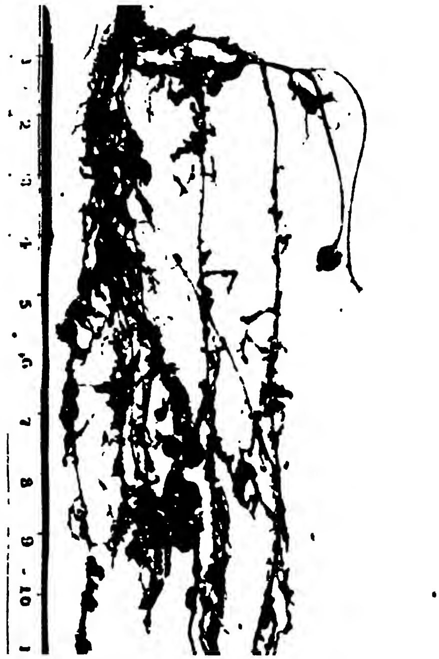

Fig. 4.

BACTERIAL NODULES ON ROOTS OF

ROCA MEDELCA (YOUNG PLANT) 2. SIRIS

It is not many years since green manuring was taken to mean only the ploughing in or hoeing of green stuff into the ground, with a view to fertilizing the soil for a crop to follow. Now, however, the expression has a wider signification, and is taken to mean also the planting of shrubs and trees, to act as perennial fertilizers amongst the particular crop which is cultivated. It is now very generally known by agriculturists that all leguminous plants, trees and shrubs, *viz.*, those which carry their seeds in pods, have the faculty of fostering upon their roots certain bacteria, which by their activities absorb free nitrogen from the surrounding atmosphere, and transform it into a fixed condition, in which form it is readily available for the support of plant life. It has been demonstrated that the special usefulness of certain crops for green manuring, and the fertilizing properties of leguminous plants and trees, are directly traceable to the presence of these bacteria upon their roots. This is a phase of the subject of green manuring which has hardly received more than a passing attention from many of those who are directly interested in tea planting. Just how the activities of these bacteria can be stimulated and encouraged, and the relative readiness with which they may be expected to seize upon the various leguminous plants grown upon the different tea soils, must of necessity be a study of great importance to such planters as are anxious to adopt the best methods, and to reap the best results from their daily labours, or from their investments in tea properties. Although the study of soil bacteriology is still only in its infancy, there has already been collated quite an array of established facts which must be of immense importance to all agriculturists. New facts are constantly being brought to light in this interesting study. All the latest works on every branch of scientific agriculture have much to say upon the activities of bacteria, both in regard to the formation and the fertilization of soils.

The form assumed by the root-nodules in which bacteria are found is different in the case of different plants, although the spherical form is the most common. Plate XVI, Fig. 1, illustrates the shape of full-grown nodules upon a young plant of *boga medeloa (Tephrosia candida)*, although the plant was only four months old

from seed. An interesting fact in connection with this is that in the early stages the nodules upon the roots of this plant are always spherical. They become elongated into egg shape as they approach maturity. Some plants carry the nodules in the form of clusters of small individuals, as in the case of *siris (Albizzia stipulata)*, shown in Fig. 2, or in clusters of larger individuals, as on the roots of a full grown specimen of *boga medeloa*, shown in Fig. 3; while in some instances, as in the illustration of *moshym dal*, Fig. 4, and *dhaincha (Sesbania aculeata)*, Fig. 5 in Plate XVII, many of the nodules tend to become anastomosed, or run into one another, especially when the plant is grown upon land which has been enriched by manure or an accumulation of organic matter.

It has been stated that very vigorous growth above ground, and any special enrichment of the soil with manure or mulch, is against the formation of nodules upon the roots; but this is not the experience of the present writer; quite the reverse. The bacteria seem to revel in a comparative abundance of organic or nitrogenous material in the soil, and multiply with remarkable rapidity. The experience of many observant tea planters is that a crop sown for green manuring is more effective the second year than the first year of application.

In the selection of the particular kind of plants or trees for green manuring upon a tea estate, there are many important factors to be considered, and it is a want of sufficient consideration of these points which has caused some planters to arrive at the conclusion that green manuring on their particular estates is of no practical use. It is necessary to find out the particular variety which suits the particular soil. There are many kinds to choose from, as India is very well off in having a large catalogue of leguminosæ indigenous to the country. There is the important fact that the tea plant is permanently in the soil; and in growing any plant or tree between the lines of tea bushes there is to be considered the question of action and reaction of shade from both sides. There are many kinds of leguminous trees which might prove very good nitrogen fixers, but the shade of their foliage is altogether too dense for the health of the tea bushes. On the

PLATE XVII.

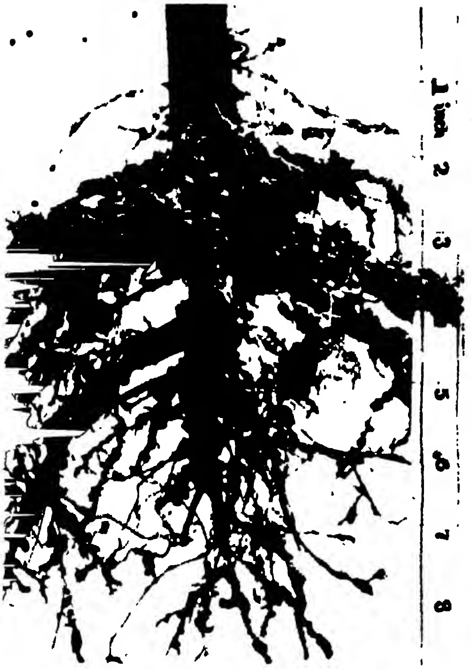

Fig. 5.

Fig. 6.

BACTERIAL NODULES ON ROOTS OF

5. DHAINCHA.

6. NEPAULI BHOT MAS

other hand, there are leguminous plants which grow splendidly upon open ground in certain climates, but they languish when sown under the partial shade of tea bushes. Climate and altitude have also a great deal to do with success or otherwise of measures of this kind. Some plants grow well in every respect upon one portion of an estate, while upon another portion they completely fail. The reason probably is in a difference of tilth in the soil. A very stiff soil is generally unsuitable for an annual crop of leguminous plants, unless treated with a dressing of something like farmyard manure or castor meal.

The planting of suitable leguminous trees amongst the tea is the ideal method of green manuring; because when once done the result is permanent, and the nodules are formed upon the roots regularly every year, as these roots extend their ramifications, and they provide a new supply of nitrogen for the use of the tea bushes continually. The tree most in favour on tea estates is the *kala siris (Albizzia stipulata)*, as it is hardy, and its very light foliage does not seriously shade the tea in the growing season. On some of the estates in Assam and the Dooars other varieties of the Albizzia are more in favour, also one or two varieties of Dalbergia, because of their leaves being more persistent in the dry season. Whatever kind of tree is used, it is quite necessary to pollard or lop the branches more or less at certain seasons of the year, in order to let sufficient light and air to the tea plants. The green stuff from the loppings is exceedingly valuable as a mulch for the tea. The only drawback to the use of trees for green manuring is the length of time which must elapse before perceptible benefit can be obtained.

There are several kinds of leguminous shrubs which grow rapidly, and give a good return within two or three years. The most useful of these in North India is the *boga medeloa (Tephrosia candida)*. This is rather a handsome shrub, and when in full flower in the autumn, with a mass of white blossoms like sweet peas, it presents an interesting sight. It is a most valuable plant for green manuring, as it can be grown on any kind of soil, and seems even to thrive best upon poor dry land where other green manuring plants can hardly be got to grow at all. An important

fact also is that the bacteria are attracted to this plant most readily, as the nodules begin forming upon the roots by the time that the plant is but six inches high. The usual custom is to sow the seed at the time of the early rains, in every second line between the rows of tea, a few seeds being sown in a cluster in the centre of the space between each four bushes; then covered lightly with soil, and protected by a tripod of short stakes. A better plan is to sow in a drill right along the line, about three inches apart, and thin out as the plants get up and prove to be too close, until they are about four feet, or eight feet, apart in the alternate lines. The plants must be kept lopped at intervals, so as to avoid giving too much shade to the tea bushes. This can be done three times a year, and the green stuff lopped off is about 90 to 100 maunds per acre at each lopping, when the plants are growing at a distance of 8 × 4 feet. This proves a very valuable mulch, the organic matter alone representing an important contribution to the soil, irrespective of its richness in nitrogen, and the store of nitrogen added underground.

It is customary to allow the *boga medeloa* to grow for about three years, and then uproot it, and trench all into the ground at the time of deep digging.

A still more rapid result can be had by sowing an annual crop between the lines of tea bushes. There are several varieties of crops commonly grown in North India which have proved more or less suitable for this purpose. Foremost amongst these is the *mati kalai* (*Phaseolus Mungo*, or *P. aconitifolius*). In North Bengal it is commonly called *kalai dal*. This is largely used on tea estates in Assam, and on the lower slopes of some tea gardens in Darjeeling and Dooars; but it does not grow well at any altitude above 1,000 feet. There are about a dozen different varieties of *Dal* and Soy Bean in cultivation on the hills. Most Darjeeling planters prefer the soy bean, commonly called *bhot mas*, for sowing amongst the tea; but it is doubtful whether the most suitable variety has yet come into general use. The principal objection to most varieties is their twining habit, and the consequent damage which they do to many of the tender new shoots on tea which has

been heavily pruned. A plant which has proved particularly useful for almost any elevation is the *moshym dal* (Fig. 4). It is hardy, and stands the shade of the bushes fairly well, and the foliage of it is not so troublesome to the tea branches as most of the other sorts. The *Barmelli bhot mas* is partially erect growing, and a very suitable kind for green manuring. The *Nepauli bhot mas* grows quite erect (Plate XVII, Figs. 6 & 7). and is suitable for high elevations, but does not grow well upon very poor soil. The nodules which are shown upon the roots of this plant in the illustration are typical of the several varieties of Soy Bean and Dal. *Dhaincha* (*Sesbania aculeata*) shown in Fig. 5 is a plant which has proved very useful in some estates. and deserves to have a larger vogue. It grows erect, to a height of eight or ten feet : but is generally lopped at intervals. in order to keep it from giving too much shade to the tea. It is not an edible plant. *Arhar dal* (*Cajanus indicus*) is an erect growing variety of Dal. and at one time a good deal was expected from it : but in practice it has not proved so satisfactory as had been expected.

In the selection and cultivation of annual crops for the purpose of green manuring there are one or two facts of great practical importance. There is generally a direct ratio between the amount of growth developed above ground and the volume of nodules upon the roots. A crop which is sown early, provided that the conditions are favourable for growth, produces a much more abundant growth of green stuff than the same crop sown at a comparatively late season. Native farmers, who grow such crops for the resulting grain, sow rather late in the season, in July or August, as they know that the early sowings give too much green stuff and very little grain. The best time to sow for green manuring is whenever good spring rain has fallen ; only that it is to be remembered that the crop will not grow at all until the ground is wet to a depth of at least six inches. In some cases it is possible to sow in April, in others where the climate is naturally dry it is not possible to sow successfully till the middle of May or June. The seed is sown in the rows between the tea bushes, after the soil has been dug over, and is lightly covered over with soil after sowing.

In some cases the seed is broadcasted, but with the bigger and stronger varieties it is advisable to sow in a drill down the centre of the space. About 40 lbs. of seed to an acre is ample. In the case of the smaller classes of seeds there will be more plants, while the larger seeds give larger plants ; but the weight per acre works out about the same. Sowing may be made in every line, and the coolies be allowed to tread freely upon the growing plants when plucking the tea leaves, as the light treading with bare feet does no harm to the young dal. In the case of twining or trailing varieties a little labour has to be spent upon training the young plants as soon as they begin to climb over the tea bushes. The plants are carefully pulled off and laid along the ground. Children or old women do this quite quickly, and the cost is not great. When lying along the ground many of the stems are induced to send out adventitious roots ; and the writer has frequently seen stems of *moshym dal* fixed to the ground in this way for a distance of as much as two and three feet, with clusters of roots at intervals of two or three inches the whole way along the stem, and six inches deep in the ground ; each cluster of roots having a complete set of bacterial nodules attached.

The length of time which should elapse before the crop is cut or dug into the ground varies in different circumstances ; but is usually about six to eight weeks, and about two weeks longer on the hills. A good rule is that the crop has reached its maximum of usefulness when the plants begin to flower. On level country it is then hoed into the land ; but on steep hillsides, where it would be nothing short of madness to dig during the rains, the crop is merely sickled and left upon the ground as a mulch, till the time has arrived for the autumn deep cultivation. No planter need be afraid of losing much by sickling instead of digging in such circumstances. A little of the nitrogen will certainly go off into the atmosphere from the green stuff during the process of drying ; but the principal benefit is already in the soil, as has been proved by scientific analysis, and by practical experiment.

Dr. Mann has stated that green manuring may be expected to yield an increase of about sixty pounds of tea per acre. This is

quite a moderate estimate. By actual experiment the writer has noted an increase of fully 70 lbs. of tea per acre on a hill estate, at an elevation of 4,000 feet, and the increase on plains estates must be considerably more.

The failure, or partial failure, of some tea estates to reap definite benefit from green manuring may be due to several causes. The kind of crop selected may not have been suitable for the particular climate or soil, and some other variety might be found more successful. The cover of tea bushes may have been too dense for any crop to grow through. In such cases the only time when green manuring can be successful is immediately after heavy pruning. A partial failure is sometimes caused by quite a sordid fact. The dal which is used for seed is a palatable and nourishing diet for the cooly, and if supervision is not very keen the cooly carries away in some recess of his clothing a considerable portion of the grain which he is supposed to have sown upon the ground, with quite a natural result. In order to checkmate conduct like this it has been found effective to steep overnight the seed for each day's sowing in liquid manure. Not cow manure, as a Hindoo would never consider that any contamination, but in horse or goat manure. The liquid manure assists germination of the seed, while it ensures that the seed will be duly sown.

THE FEEDING OF PRICKLY PEARS*

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AND

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DURING the month of August 1912, a letter from Mr. Norton (American Missionary) of Dhond, appeared in the "Bombay Guardian," drawing attention to the value of prickly pear as an emergency ration when properly prepared and fed.

In October of the same year, Professor J. B. Knight of the Poona Agricultural College, visited Dhond and inspected Mr. Norton's work. In a note on his visit, Professor Knight reported that the experiments had every appearance of being genuine, but that Mr. Norton had no record to show the cost of preparation.

An experiment was commenced at the Government Civil Dairy, Kirkee, in January 1913, and owing to the satisfactory results obtained there, demonstrations were commenced at the cattle camps, which had been started in the Ahmednagar District, with the object of saving cattle which were being lost owing to the fodder famine.

Object.—The object of the experiment at Kirkee was to place beyond doubt the possibilities of cactus as an emergency ration in times of scarcity, to decide the best method of preparing and feeding it, and the cost of preparation.

Animals used.—Six bullocks were purchased in the famine-stricken district of Ahmednagar, for this purpose. They were in exceptionally poor condition on arrival, with the exception of one bullock, which was in fair condition.

Kind of pear used.—The pear used was the common variety, which is to be found anywhere along the roadsides, on waste lands,

* An extract from a paper on "The Feeding of Prickly Pears and Cotton Hulls" read at the Provincial Agricultural Conference held at Poona, September 1913.

etc. The chemical analysis of the pear, made during both wet and dry seasons, was :—

	Wet season.	Dry season.
Moisture	92·65	79·32
Ether extract	·22	·78
Albuminoids	·31	·68
Soluble carbo-hydrates	4·37	11·61
Woody fibre	·85	2·48
Ash	1·60	5·13
Total	100·00	100·00
Containing Nitrogen	·049	·11
Containing Sand	·12	·04

Preparation.—The spines were removed by burning, several types of "Primus" stoves being used for the purpose.

The price of the stoves and the cost of preparing the pear with the different varieties were :—

Name of stove.	Price.			Quantity of pear prepared per hour.	Cost of preparation.		
	Rs.	A.	P.	lbs.	Rs.	A	P.
Primus No. 1	5	12	0	31	0	1	2
,, No. 2	8	12	0	31	0	1	2
Vesuvius (flat flame)	15	8	0	60	0	1	5
Vesuvius (round flame)	15	8	0	55	0	1	5
Etna	10	8	0	50	0	1	7
Petrolia	13	0	0	55	0	1	3
Effective	22	0	0	100	0	2	0

The price of oil has been calculated at Rs. 2-0-0 per tin, and labour at Re. 0-5-0 per day. The results arrived at are the average of a large number of trials.

In burning, it is necessary to be careful that the pear is properly burned; otherwise, the pear will be refused by the cattle. Previous failures are most likely due to the imperfect removal of the spines. However no matter how much care is exercised, some very fine hair-like spines will be left, but these will have no effect. Of all the stoves tried the "Effective" proved most economical. This stove has a double burner, and a flat flame, and will burn 100 pounds of pear in one hour, at a cost of Re. 0-2-0 for oil and

labour, or at the rate of 1,000 pounds per day of 10 hours for Re. 1-4-0. The slabs after burning are cut into small pieces, by passing them through a Smalley chaff cutter, or by chopping them on a wooden block with a knife. The former is of course quicker and more convenient, but the latter also gives good results when the quantity to be prepared is not excessive; the knife used should be similar to that used for chopping *kadbi*.

Feeding the pear.—As the pear fed alone would not be sufficiently nutritious to form a maintenance ration, an addition of 6 per cent. of cotton seed was included, that is for every 100 pounds of pear, 6 pounds of cotton seed were added, and this mixture was fed during the experiment. At the commencement small quantities of the pear mixture were given, with a quantity of chaffed *kadbi*, the mixture being increased and the *kadbi* decreased gradually, until after about a week the *kadbi* was altogether discontinued. Of the six bullocks, four took to the pear readily, and after about ten days ate it greedily, one gave some little trouble, but also ate it readily after having become accustomed to it, which it did after about a month. The sixth bullock, however, gave a considerable amount of trouble, and only commenced to eat the pear at all readily towards the end of the experiment. In this case the cause was most likely the very emaciated condition in which he arrived and commenced the experiment, for it was difficult to get him to eat sufficient good fodder to regain condition.

Results.—The first result to be noticed was, the colour and consistency of the fæces, and the excess of urine. The fæces were of a slatish colour, and showed a tendency to become too liquid, but at no time were they so liquid as to suggest scouring, nor was there any offensive smell. The urine was somewhat in excess in quantity, but appeared quite normal in quality. At the beginning of the experiment there was a loss of weight varying from 2 pounds to 60 pounds, this, however, was very soon made up, and a steady gain in weight was made, until a maximum was reached, after which the weights were practically constant. The greatest gain was 70 pounds. The average quantity of pear consumed was

32 pounds per head per day, varying accordingly as the pear contained more or less moisture. This average works out to 72 pounds per 1,000 pounds live weight. Taking the average analysis of the pear and cotton seed, we find that we have a maintenance ration giving :—

		Protein.	Carbo-hydrates.	Fat.
Pear ..		·24	3·84	·24
Cotton Seeds		·48	·96	·50
	Total ..	·72	4·80	

Comparing this with Haeker's standard, we find a slight deficiency in carbo-hydrates, but this is practically made good by the excess in fat. Haeker's standard requires ·7 lb. protein, 7 lbs. carbo-hydrates and 1 lb. fat, so that the pear mixture is only deficient by ·58 lb. carbo-hydrates, after the surplus fat and protein has been converted to this nutrient. This deficiency is of no particular importance, as Haeker's standard is a very high one, and, if compared with some of the lower ones, a small margin of excess would result.

As the weight of the animals increased, their appearance improved. At the commencement of the experiment they all looked dull, miserable and emaciated, with staring coats, but they rapidly improved, and after six to eight weeks they appeared like totally different animals, their coats became smooth and glossy, eyes bright, and they had a general appearance of health and well-being.

The pear was also fed to 19 cows and 19 buffaloes which were in milk, mixed with their ordinary feed, which was proportionately decreased in quantity. It was given up to 14 pounds per head per day, and after three or four days they ate it readily. The object was to find out if the succulence of the prickly pear was of any value for increasing the milk yields when no other green fodder was available, but for various reasons we were obliged to discontinue this part of the experiment without getting any decided results. This will be tried again later. The dry cattle and young stock of the dairy at Manjri were also fed the pear with a mixture

of cotton seed hulls, cotton seed and molasses. The feed consisted of 19 pounds of pear, 8 pounds of cotton seed hulls, 1 pound of molasses and 1 pound of cotton seed. The animals had fallen off condition, owing to the grazing having become scanty, but when put on the feed above-named they rapidly regained their former condition. They exhibited no signs of abnormal looseness of the bowels at any time, neither did they require any coaxing to eat the mixture, even on the first day. The bullocks did not take any water worth mentioning, except when salt was added to the pear, but with the addition of 2 ounces of salt, they drank a normal quantity.

Summary.—To sum up, it has been clearly demonstrated that the prickly pear if properly prepared and mixed with 6 per cent. of its weight of cotton seed, is not only enough to support life, but will enable an animal to regain condition even after it has become very poor from semi-starvation, that the cultivators could save their cattle in times of famine by feeding the above, the cost of preparation being very low. With the "Effective" stove enough pear could be prepared for a pair of bullocks, weighing 1,450 to 1,500 pounds at a cost of Re. 0-1-6 for oil and Re. 0-3-3 for the necessary cotton seed, or a total of Re. 0-4-9 per pair per day. One stove would be sufficient to burn pear for 10 pairs. The pear was used with profit at Manjri, for the dairy dry stock, when fodder was dear, and effected a considerable saving. It is profitable to feed it as a part of the ration at any time when fodder is scarce and prices are high. No ill-effect was noticed at any time throughout the whole six months of the experiment, and it is still being carried on to find if there will be any ill-effect produced by feeding it for a much longer period. A point worthy of notice is, that, although the stoves used worked well if properly managed, and the directions which accompany them are carried out, they will soon go out of order, if carelessly handled or negligently treated.

As a result of these experiments, demonstrations were started at the cattle camps in the Ahmednagar District, to demonstrate to the public the value of prickly pear in time of famine, and to induce them to feed it to save their cattle.

Cattle used.—Eleven bullocks were specially purchased for demonstration, as the cultivators were in the beginning unwilling to loan their bullocks for the purpose, as they feared that injurious results would follow the consumption of the prickly pear.

Stations.—Demonstrations were given at Ahmednagar, Lakh and Miri.

Method of preparation.—This was the same as at Kirkee.

Results.—The consumption of pear per 1,000 pounds live weight averages 58 pounds, but in addition to this 10 pounds of hay per 1,000 pounds of live weight were fed. Cotton seed was added to the ration as at Kirkee. The total gain in weight was 84 pounds, the maximum being 25 pounds and the minimum *minus* 13 pounds. This is a considerably better ration than the Kirkee one. Owing to no rain having fallen at Ahmednagar, the pear was very dry, and therefore contained a higher percentage of nutrients, than at Kirkee. No analysis is available, but for comparison, an analysis made at Kirkee during the driest season has been taken. This shows that the animals consumed digestible nutrients per 1,000 pounds live weight :—

			Protein.	Carbo-hydrates.	Fat.
58 lbs. prickly pear	..	..	·26	4·49	·30
10 „ hay ..	..	..	23	2·86	·17
4·17„ cotton seed	..	..	·46	·93	·50
	Total	..	·95	8·28	·97

This, compared with Haeker's standard, after supplying maintenance, leaves available for work ·25 protein, 1·28 carbo-hydrates, and ·87 fat.

The bullocks were given light continuous work, such as harrowing, sowing, and bringing in the necessary prickly pear.

The condition of the animals at the beginning was poor, and they remained practically in the same condition throughout the demonstration.

The cost of preparing the pear was, taking labour into consideration, somewhat higher than at Kirkee, but there was no appreciable difference in the oil consumption.

No ill-effects due to feeding the pear were noticed. At Kirkee, as already noted, the bowels were considerably relaxed, but at Ahmednagar, this was not so, owing to dry fodder being fed in combination with the pear.

After the demonstration had been in progress a short time, cattle in gradually increasing numbers began to arrive at the camps, the fear which the cultivators entertained at the commencement having disappeared after observing the result of feeding.

The strength of the camp at Ahmednagar was about 800 cattle, at Lakh about 500, and only 16 at Miri. Those at Ahmednagar were fed pear, dry grass, and cotton seed. At Lakh about 120 cows were fed pear and cotton seed without any additional fodder, while the balance were fed as at Ahmednagar.

When the camps were closed owing to improvement in local conditions, a number of cultivators at Lakh borrowed the stoves from the camp and continued to feed the pear to their cattle at their own expense.

NOTES ON DRAINAGE AND GREEN-MANURING

BY

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THE crop-producing power of the soil in India is frequently limited by two factors—moisture and nitrogen in an available condition. As a rule, the supply of water for crops is in defect and has to be supplemented by some form of irrigation. Sometimes, however, moisture is in excess and an increase in crop can be obtained by some form of surface drainage. In the case of organic matter and available nitrogen, a deficiency in these substances is the rule and one of the most important considerations in any scheme of soil management is the maintenance of an adequate supply of humus in the cheapest possible way. At the meeting of the Bihar Planters' Association in January last, the attention of the planting community was drawn to some of the results obtained at Pusa, both in the case of drainage and also with green manures. As they are likely to prove of interest outside Bihar, it has been decided to reprint these notes in the *Agricultural Journal of India.*

DRAINAGE AND THE PREVENTION OF LOSS OF SOIL BY RAIN WASH.

Our experience in growing crops in the Botanical Area at Pusa during the last eight years has led to the conclusion that some system of surface drainage, combined with the prevention of loss of soil by rain wash, is the first condition in improving the crop-producing power of the soils of Bihar. Without drainage, water-logging is bound to occur, while the annual loss of fine soil that is taking place every year on the large *zerats* near the indigo factories can easily be appreciated when the fields are visited in the monsoon during heavy falls of rain.

The subject of drainage and soil denudation has been referred to in the previous addresses to the Bihar Planters' Association published in Pusa Bulletin No. 33. This paper has been distributed to all members of the Association. The loss of crop due to water-logging was shown to be very great and in the experiments cited was over sixteen bushels of wheat to the acre in a single season. This loss of crop was shown to be due to the destruction of available nitrogen in the soil by water-logging, probably caused by denitrification. It was also pointed out that green manuring with *sanai* (*Crotalaria juncea*, L.) only gave uniformly good results on high lands which had been drained and that water-logging after the *sanai* crop was ploughed in often reversed the effect of the green dressing and led to a smaller crop than that produced by unmanured land. A method of surface drainage by means of trenches and grass borders was described in detail and great stress was laid on the importance of controlling the rainfall and allowing each plot to deal with its own rain only. Lastly, the importance of this system of drainage in preventing the loss of fine soil was emphasized in the following words :--

"The experiments on surface-drainage at Pusa have demonstrated a further point in the improvement of the high lands in Bihar to which I should like to direct your attention. This is the prevention of surface wash or the removal of the fine particles of soil by the rain-water which runs off these fields towards the rice lands. Whenever the slope is great enough for water to move, this wash is going on and is one of the factors responsible for the destruction of the fertility of the high lands. On the plots at Pusa, the grass borders tend to prevent the loss of the fine particles of the soil by surface wash. Consequently, the lower ends of the plots are getting higher every year and the whole surface tends to become more and more level. The increase in height of the lower areas represents the amount of soil that would have been lost by rain-wash had not this been checked by the grass borders. Further, the lower ends of the plots which have received the surface-soil from the upper areas are yearly increasing in fertility. The fine

soil is now being held up and this increases the water-holding capacity and fertility of the soil very markedly. If these effects can be obtained in three years in plots one acre or less in area with slopes imperceptible to the eye, it requires no great imagination to realize what must be taking place on the large fields surrounding indigo factories. The annual loss of fine soil must be enormous and its prevention by the simple method of drainage advocated last year will repay the cost and trouble involved. Further, the fertility of the land will be improved, water-logging will be checked and the introduction of green-manuring with *sanai* and other crops into the general agricultural practice of Bihar will be accelerated.''

Since this Bulletin was written, the system of surface drainage adopted in the Botanical Area at Pusa has been taken up on two estates—Dowlutpore and Dholi. At Dowlutpore, the *zerats* have been divided into plots one bigha in area, separated by drainage trenches, the small trenches communicating with larger ones which act as small drainage canals and carry off the excess water. On this estate the system is being extended at the rate of about one hundred bighas a year and this centre will serve as a good object-lesson for other estates where it is desired to rent the fields to small cultivators. The bigha plots ensure good drainage and also allow of successful green-manuring with *sanai* for crops like tobacco. Further, the bigha plots enable accurate records of the crop-producing power of the land to be kept and also save much time in measuring the land and also in allotting it to the selected tenants.

On the Dholi estate, the plots are larger so as to admit of the use of reapers and other labour-saving devices in the cultivation of wheat for seed purposes. This system of plots, each about five bighas in area, is suitable for estates which either cultivate their *zerats* or let out the land to well-to-do ryots who require areas of more than one bigha. Mr. Danby, in a letter, dated January 3rd, 1914, gives his opinion on this system of drainage as follows :—

'' During the past year I have applied the system of surface drainage to some 40 bighas, and I intend to extend it to the whole

of my factory *zerats* here and at the outworks. The lands which I drained in this way this year were formerly, in a wet year, more or less water-logged the whole of the rains owing to the water from the higher lands draining into them. This year I was able to cultivate and keep them clean all through the rains, and even after the late rains which we had this year I was able to sow wheat in them before the end of October."

One great advantage of a system of drainage in the heavier low-lying lands in Bihar, referred to in the above letter, should be emphasized. This is the ease with which these lands can be kept free from weeds during the rains and put down to *rabi* crops in good time. As is well known, it is impossible in Bihar to keep ordinary undrained low-lying fields clean by surface cultivation alone during a heavy monsoon on account of the fact that the soil is for long periods of time too wet for any form of cultivation. Further, at sowing time, such lands are not dry enough to be ploughed till late when the difficulty of reducing them to a good tilth is very great. These circumstances greatly lower the value of low-lying lands. When, however, these lands are drained and have to deal with their own rainfall only a great change takes place. Cultivation is easily possible during the rains while they can be prepared with comparative ease in good time for sowing *rabi* crops. Once drained these heavy lands give large crops year after year without manure. It is no exaggeration to say that the value of low-lying, heavy lands in Bihar, which are capable of drainage, can be doubled by the system of surface drainage we have advocated.*

The value of this method of drainage in preventing the loss of fine soil by surface wash is now very evident in the Botanical Area at Pusa. The process of natural terracing, which gradually takes

* The question of the drainage of the low-lying areas in North Bihar, now under paddy, arises naturally from the Pusa experiments. At present, these lands grow precarious crops of rice and command but a small rental. If they were protected from the rain-wash from higher areas by means of drainage canals and then drained by some such methods as are in use in Lombardy, these areas would grow enormous crops of wheat.

What is required are accurate experiments on the subject to determine the cost of drainage and the increased value of the land

place, is now well marked. The lower ends of the plots are now considerably raised, in some cases as much as 6·5 inches in four years. This raising of the lowest ends of the plots represents the deposition of silt by rain-wash carried from the upper areas of the fields. What was once an even surface is now becoming a series of terraces. Had the fields not been cut up into sections much of the deposited silt would have been carried away by surface wash to the rice lands below, and so lost. Several measurements of the rise in the levels of the lower sides of the Pusa plots since 1909 have been made. In plot 1 of the Northern Trial Ground, which slopes from south to north and is 94 feet wide, the rise on the north side amounts to 6·5 inches. Similarly in plot 2 of the Pentagonal Field, which slopes from north to south and which is 194 feet wide, the south side has been raised 4·5 inches in the last four years.

In order to carry out this system of drainage in practice a drainage map is essential. This can best be obtained by following the system originally devised by Sir Edward Buck in 1870 when Settlement Officer in the Farrukhabad District. This consists in marking on an ordinary map the directions in which rain water runs off the land. This enables the drainage lines to be determined far more easily and cheaply than by any system of taking levels.

Conclusions. The first condition of progress in any scheme of improvement in the crop-producing power of the soils of Bihar is a system of surface drainage by which each field deals with its own rainfall only. In this way all lands are benefited. On high lands, green manuring with *sanai* can be carried out with safety while the cultivation and crop-producing power of lower lands are materially increased. The Pusa system of drainage also prevents the denudation of the soil by rain-wash and the loss of fine particles which are now carried away every year from the high to the low-lying areas. The cost of this system is small and is well within the means of any Indigo estate or *zamindar*.

Green-Manuring with Sanai in Bihar.

A supply of organic matter in some form is essential to the maintenance of the fertility of the high lands in Bihar. If the humus in the soil of these lands is allowed to run too low, the ferti-

lity falls off and the fields are unable to retain enough moisture to ripen off a *rabi* crop. This is the reason why the high lands respond so markedly to applications of indigo *seeth*, to farm-yard manure and to various oil-cakes. To a less extent a *rahar* crop, which adds by the fall of its leaves and flowers a good deal of organic matter to the soil, also improves the fertility of these lands. With the diminution in the cultivation of indigo the supply of *seeth* is now insufficient for the higher lands. Some *seeth* substitute must therefore be looked for, and our experience at Pusa proves that a green crop of *sanai* ploughed in during the monsoon is a valuable substitute for indigo *seeth*.

The earlier results obtained with *sanai* in the Botanical Area at Pusa have been published in the *Agricultural Journal of India* (Vol. VII, Part I, 1912). This work is also referred to in Pusa Bulletin No. 33. In the case of tobacco, the experiments showed that two conditions are essential for success in ploughing in *sanai* as a green manure—drainage and time. Green-manuring should only be attempted on light, high-lying lands which are *well-drained* so that each field has to deal with its own rainfall only. Soakage from other areas after the green crop is ploughed in leads to great loss of fertility and often to a yield below that of unmanured land. *The time of ploughing in is everything.* In 1910, we recommended July 15th as the best date for turning under the *sanai* for the succeeding tobacco crop. Subsequent experience has confirmed this. Tobacco is usually transplanted about the middle of September, so that there is a period of two months for the green crop to decay and for a portion of its organic matter to be transformed into a form which the tobacco crop can take up. We found in 1909 and again in 1910 that if, for any reason, the succeeding crop after *sanai* is planted late and the period of two months became three to three and a half months, then the value of the green crop is lost and the available nitrogen in the soil disappeared.

During the past year we have obtained further confirmation of our original recommendations. An even plot of light, high-lying, drained land in poor condition was green-manured with *sanai* for tobacco and divided into three plots. In the first plot

PLATE XVIII.

TOBACCO GREEN-MANURED WITH SANAI.

the *sanai* was ploughed in on July 15th, in the second on August 7th and in the third on August 28th. Cigarette tobacco (Type 28) was planted into all these plots on September 25th and 26th, the plants being set out 30 inches apart each way. The dates of sowing and ploughing in the *sanai* were as follows :—

		Sanai sown.	*Ploughed in.*
Plot 1 ...	...	May 18th.	July 15th.
Plot 2 ...	..	June 15th.	August 7th.
Plot 3 ...	...	June 30th.	August 28th.

Sown in this way the amount of green manure ploughed in in all the plots was practically the same.

The results of the experiment were very striking. The tobacco in plot 1 grew very rapidly from the beginning and has given the maximum crop that can be grown for cigarettes. Plot 2 is not so good while plot 3 is poor. The results are shewn in the Plate opposite. In all three cases the photographs were taken at the same distance from the camera.

These experiments again emphasize *the importance of time* in ploughing in the green crop. Any period less than two months is too short for the green manure to decay. We have already shown that after two months there is a loss of fertility following green-manuring. *Sanai* gives the best results when put in about two months before the next crop. It is a counsel of perfection to say that all *sanai* must be put in on a certain day. This is impracticable under estate conditions. There is of course some latitude, and it would be a good rule to lay down that *sanai* for tobacco should be put in between July 7th and July 21st. Any crop not put in on July 21st should be cut then and left on the ground. Our experiments this year showed that *sanai* decays faster, if cut and allowed to wither a few days on the moist soil before being ploughed in, than if put under green.*

* Tobacco is a very suitable crop for experiments with green manures. In the first place, it is an excellent soil-analyst and gives most accurate indications of the amount of available nitrogen in the soil. In the second place, it can take up large quantities of nitrogen to advantage as it is grown for leaf and not for seed. In crops like wheat, on the other hand, a large amount of available nitrogen leads to rank growth which is then not only more liable to lodge but also more liable to rust attacks.

Conclusions. The experiments with *sanai* as a green manure for tobacco in the Botanical Area at Pusa have led to very definite conclusions. Drainage is essential for success with green-manure on the high lands. The *sanai* should be sown on the early rains in May and ploughed in as near July 15th as possible. Where large areas have to be dealt with the period from July 7th to July 21st would be suitable. Any crop left on July 21st should be cut at once, left on the surface and ploughed in as soon as possible. To get the maximum benefit of the green crop the interval between the ploughing in of the *sanai* and the transplanting of the tobacco should be eight weeks. A longer or a shorter time leads to loss.

NOTES

Rotting of Pomegranates.—Specimens of pomegranates were recently received from a garden in Bombay, in which the fruit, though of excellent external appearance, were blackened and rotting inside. The rot was found to be due to a fungus known as *Sterigmatocystis castanea* Patterson, and the disease to be identical with one described in the American journal "Phytopathology" for June, 1912, as a new and serious disease of this fruit, which was first observed in the United States in 1910.

The fruit appears perfectly healthy on the outside, but when cut open, the seeds and pulp are found blackened either wholly or in part. In the more advanced stages there are cavities inside, filled with a brown powdery substance, composed of the spores of the fungus. The characters of the disease are exactly as described in the United States, and the fungus agrees perfectly with the American description of *Sterigmatocystis castanea*.

It is suggested in the United States that the fungus gains an entry while the calyx is open. Subsequently the calyx closes and the parasite develops within the growing fruit. If this be the case, it is hard to see how the disease can be checked. But there is another possibility. Several cases are known where fruit which is externally sound is mouldy inside, and in these cases the mould is frequently some common species, whose spores are likely to be present in the air in considerable quantity. Walnuts are, perhaps, the most familiar example of this condition. Tea seed is also not infrequently affected in a similar manner, and it has been shown with considerable probability that the mould gains an entry through the punctures in the young fruit made by a large sucking insect. It is at least possible that the pomegranate rot is due to a similar cause, and if so, the question of its prevention resolves itself into

the question whether it will be possible to preserve the young fruit from such insect attacks.

If fruit growers whose pomegranates are damaged in the manner described, will direct their attention to noting whether the young fruits are fed on by sucking insects, and will catch and send to Pusa specimens of any found doing so, it may be possible to ascertain whether this hypothesis has any foundation in fact, and if so, to devise measures for checking the injury.—(E. J. BUTLER.)

A NEW SOIL DISEASE.—SULPHUR AS A SOIL IMPROVER.—In the *Journal of the Board of Agriculture* for January, 1914, there is an account by Mr. Walter Collinge of a peculiar soil disease locally known as 'Maysick' that has appeared in Warwickshire and Cheshire. The symptoms of the disease are described as follows:—

"In various parts of the field, either in large circular patches or in straggling lines, the wheat plants were turning yellow in the leaf and had only attained a height of about half that of the healthy plants. Later in the season such plants had a scorched appearance, *very little growth took place, they did not develop ears, and were of little use for straw.* Oats and rye had much the same appearance, whilst mangolds and potatoes turned yellow in the leaf, and growth was arrested to a large extent, with the result that the roots or tubers were undersized."

The cause of the disease has not been definitely ascertained. Lime has been found to have no effect on the disease, but sulphur applied at the rate of about 6 cwt. per acre seems to effect a cure after one or two applications.

The disease has been spread to healthy land by inoculation and Mr. Collinge considers that it is due to bacteria which interfere with the nutrition of the plant.

In the same number an abstract is given of a paper in the *Journal d' Agriculture Pratique* for November 20th, 1913, describing experiments with sulphur and iron pyrites as manures. Both were found to have a very marked effect (30 to 40% increase in the case of wheat and 50 to 60% in haricot beans) on the yield of

plants grown in pots, when used in conjunction with dried blood and mixed with the soil. No effect was produced when the same manures were used in conjunction with nitrate of soda.

The results of several recent experiments appear to indicate that it would always be worth while testing the effect of sulphur on soil on which it had not been previously tried.—(A. C. DOBBS.)

* * *

An Act has been passed *to prevent the introduction into British India of any insect, fungus or other pest, which is or may be destructive to crops.* The text of the Act is as follows :—

"Whereas it is expedient to make provision for preventing the introduction into British India of any insect, fungus or other pest, which is or may be destructive to crops; it is hereby enacted as follows :—

Short title.

1. This Act may be called The Destructive Insects and Pests Act, 1914.

Definitions.

2. In this Act, unless there is anything repugnant in the subject or context,—

(*a*) "crops" includes all agricultural or horticultural crops, and trees or bushes;

(*b*) "import" means the bringing or taking by sea or land; and

(*c*) "infection" means infection by any insect, fungus or other pest injurious to a crop.

Power of Governor-General in Council to regulate or prohibit the import of articles likely to infec

3. (1) The Governor-General in Council may, by notification in the *Gazette of India*, prohibit or regulate, subject to such restrictions and conditions as he may impose, the import into British India, or any part thereof, or any specified place therein, of any article or class of articles likely to cause infection to any crop.

(2) A notification under this section may specify any article or class of articles, either generally or in any particular manner, whether with reference to the country of origin, or the route by which imported or otherwise.

Operation of notification under section 3.

4. A notification under section 3 shall operate as if it had been issued under section 19 of the Sea Customs Act, VIII of 1878, and the officers of Customs at every port shall have the same powers in respect of any article with regard to the importation of which such a notification has been issued as they have for the time being in respect of any article, the importation of which is regulated, restricted or prohibited by the law relating to Sea Customs, and the law for the time being in force relating to Sea Customs or any such article shall apply accordingly.

Power of Local Government to make rules.

5. (1) The Local Government may, subject to the control of the Governor-General in Council, make rules for the detention, inspection, disinfection or destruction of any article or class of articles in respect of which a notification has been issued under section 3 or of any article which may have been in contact or proximity thereto, and for regulating the powers and duties of the officers whom it may appoint in this behalf.

(2) In making any rule under this section the Local Government may direct that a breach thereof shall be punishable with fine, which may extend to one thousand rupees.

Protection to persons acting under Act.

6. No suit, prosecution or other legal proceeding shall lie against any person for anything in good faith done or intended to be done under this Act.''

In supporting the Bill in Council, the Hon'ble Mr. J. Mackenna, M.A., I.C.S., Offg. Agricultural Adviser to the Government of India, said :—

"MY LORD,—I should like, with your Excellency's permission, to say a few words in support of this Bill.

"In proposing legislation for the prevention of the introduction into India of destructive insects or pests, we are embarking on no innovation. We are simply falling into line with the practice of nearly every civilised country which places any value on its agriculture. Such an Act appears on the Statute Book of Great Britain as the Destructive Insects and Pests Acts of 1877 and 1907 ; similar

legislation exists in practically all European countries. We find it in the neighbouring island of Ceylon and in the Straits Settlements, in Natal, the West Indies, Australia, the United States of America, Cape Colony and the South African Union. It may, in fact, be said that India is the only considerable part of the Empire where some sort of legislation of the kind is not in force. Disinfection, fumigation, quarantine, prohibition and destruction are the powers with which the Law is invested.

"That it is time for India to take some protective measures of the kind is indicated by the experience of the past and by the serious damage which has resulted from our inability to prevent by legislation undesirable importations. On the Entomological side, we have long lists of new insect pests which have been introduced, affecting pulse seeds, maize, flax, pines and yams; and we have others to fear. Had legislation been in force, we might have been able to keep out of India the green scale and the green bug of coffee which practically ruined the industry in Ceylon, and is doing very great and increasing damage in the coffee plantations of Southern India. Another dangerous import that might have been avoided is the potato moth (*Phthorimaea operculella*)—introduced into India within recent years, by seed potatoes imported from Italy. This insect attacks stored tubers, so that in some districts it has been found difficult or even impossible to keep seed potatoes from one season to another and very heavy losses have occurred.

"Amongst fungus diseases, I would mention the potato blight introduced into Northern India by the importation of English varieties at Darjeeling in 1883. The losses caused have been very great, the outbreak in the Khasi Hills in 1885 being followed by reduction of exports, in the 10 years following, of from **114,739** maunds to 8,296 maunds. In Hughly, the outbreak in 1901 resulted in a drop of 41 per cent. in the exports of the following year.

"Again, it is probable that oat rust was introduced into India in 1906; while on two occasions in the past 5 years the "pine apple" disease of sugarcane has been introduced into India from Java and Mauritius, respectively. Prompt action in destroying

the consignments appears to have been effective as no further outbreak of the disease has occurred. The danger of introducing serious diseases of this very important crop such as that already mentioned: *Sereh* from Java, Cane-Gummosis from Queensland, root diseases from Java and the West Indies, would itself warrant legislation.

"Then there is rubber, the cultivation of which is making such rapid strides in Burma and Southern India. Rubber is probably more subject to fungus diseases than any other recently introduced exotic. Its introduction was a splendid chance of testing the efficacy of measures of protection. The chance was lost and at least two of the serious diseases of the Malay Peninsula and Ceylon have been introduced into Southern India. Fortunately, *Fomes semitostus*—one of the worst, has not yet appeared: except in the Khasi Hills: let us hope that the legislation we propose will keep it out.

"It may be asked why we should only now be considering the necessity of such legislation. As Hon'ble Members are aware there has, within recent years, been a great awakening of interest in agriculture in India. The increasing demand for new crops or for improved varieties of crops suitable to India which the introduction of a highly trained expert staff has stimulated, has brought the whole world into touch with Indian agriculture and the area of our inquiry has been largely extended. We may want new crops, but we do not want new diseases, and it is to obviate the risk of such introduction that this Bill has been framed.

"There is much still to be feared. Ceylon and Java have tea diseases not yet known in India: there is the serious disease of rubber I have already quoted: there are countless diseases of crops and fruits, for the importation of which we must be prepared.

"With regard to the penal provisions of this Act, I hardly think it will often be necessary to apply them. I can hardly conceive an intentional evasion of its provisions possible. The Bill is protective rather than aggressive: defensive rather than offensive; and on these grounds I would press its acceptance on this Council:"

THE *Monthly Bulletin of Agricultural Intelligence and Plant Diseases, Rome,* in its issue of June 1913, p. 194, summarised the observations and experiments of Farneti Rodolfo—in Atti dell' Istituto Botanico dell' Universita di Pavia, Series II, Vol. XII, pp. 351-362, Plate XIV, Milan, 1913—in a short note, 657, on Cleistogamy in Rice *(Oryza sativa)* and the possibility of cross-fertilisation. From this it appears that the writer makes the somewhat sweeping remark that the pales of rice never open, before, during or after the dehiscence of the anthers. Consequently the natural production of hybrids is impossible, even as a chance occurrence, etc.

Our observations on this point in India are quite the contrary. My observations in Poona agree with those of Mr. Hector* in Dacca — that the glumes and pales in the rice plant not only open but actually remain so from 10 to 15 minutes or even more according to season, and begin to close up again after that time. And although the opening of the glume and the bursting of the anthers take place often more or less simultaneously, still it is not absolutely correct to say that natural cross-fertilisation is beyond the possibility of a chance occurrence. Cases have been observed (1) by Mr. Hector in Dacca, (2) by Mr. McKerral† in Burma, and (3) by me in Poona, in which quite distinct types have arisen, in pure line cultures which clearly point to natural crossing having taken place.

Besides I have observed a bee hovering over rice plants and alighting on flowers which had just then opened, for the purpose of collecting pollen ; consequently if the flowers open naturally and are visited by bees just during the process of opening, will it be too much to say that chances for natural cross-fertilisation do exist ?

It is quite possible that conditions of climate and atmospheric temperature have something to do with the opening or not of the

* *See* "Notes on pollination and cross-fertilisation in the common rice plant, Oryza sativa, *Linn.*" *Memoirs of the Department of Agriculture in India*, Botanical Series, Vol. VI, No. 1, June 1913.

† *See* article on "Some problems of rice improvement in Burma," *Agricultural Journal of India*, Vol. VIII, Part IV, October 1913.

flowers as the writer observes, but as the article in question does not clearly modify the statement with regard to cleistogamy in the rice, it has been considered desirable not to let it go without a comment.

My observations correspond with the statement made by Fruwirth (Die Züchtung der Landwirtschaftlichen Kulturpflanzen Funfter Band, p. 37) "Die Narben treten auch bei Voller Offnung des Spelzenwinkels, die 30-35 betragt, nicht aus dem von den Spelzen umschlossenen Raum," *i.e.*, "with increase of the angle between the glumes, which amounts to 30-35, the stigmas do not come out of the space enclosed between the glumes." Here there is a mention, therefore, that the glumes do open to a considerable extent.

As regards crossing I may quote the same authority, pp. 40-41: "Bei Nebeneinanderbau nicht selten Bastardierung eintritt," *i.e.*, "crossing is not infrequent when varieties are cultivated side by side."—(R. K. BHIDE).

* * *

SPINELESS CACTUS IN THE UNITED PROVINCES.—In a recent letter to a newspaper of these provinces attention was drawn to the advantages of the spineless cactus as a famine fodder plant and a recommendation made that it should be tried in these provinces. Experiments have been carried on with this plant by the Department since 1906. It has not done well in Bundelkhund where it is principally required and even when carefully cultivated, growth has been only nominal. At Cawnpore sufficient stock has been propagated to admit of a large scale experiment, which is now proceeding; the spineless cactus having been planted out among babul and left to itself, so that an opinion can be formed as to the likelihood of its propagating naturally in a wild state. So far the results are not very promising. (From *U. P. Agricultural Notes* for January, 1914.)

* * *

TRIALS WITH PRICKLY PEAR AS FODDER.—Experiments have been made on the utilization of ordinary prickly pear as fodder.

The spines having been removed by scorching with a special type of oil lamp (working on the Primus stove principle); the cactus was cut up into small pieces and fed at the rate of 5 lbs. per animal per day mixed with dry juar stalks (*karbi*) and *bhusa*, no grain being given.

A pair of young bullocks were fed in this way for three weeks, no grain being given: weekly records of weight were kept and at the end of that period it was found that one animal had gained considerably in weight whilst the other's weight had remained constant. The experiments are still in progress.

It is not suggested that prickly pear is of any large value as a food for working cattle, but in famine-stricken districts where cactus is available it may prove a useful addition to the scanty fodder supply.—(From *U. P. Agricultural Notes* for February, 1914.)

THE experiments with storing juar fodder in silo pits at the Benares Co-operative Dairy have given satisfactory results. On one pit being opened it was found possible to sell the silage at 2 maunds, 30 seers the rupee, which is a far lower rate than fodder is selling in the neighbourhood.—(From *U. P. Agricultural Notes* for February, 1914.)

REVIEWS

RURAL SCIENCE, BY J. J. GREEN, B.Sc. (Published by Messrs. Macmillan and Co., London.) Price 1*s.* 8*d.*

THIS small book forms one of a series of elementary science text-books known as "First Books of Science" which is being published by Macmillan and Co. It furnishes an excellent example of the kind of instruction which may be provided for the higher classes of Rural Primary Schools without actually attempting anything in the way of a regular course in agriculture.

The book is divided into fifteen chapters, seven of which are devoted to a study of plants, seven to soil and one to the inter-relationship of soils and plants. The study of plants is taken up, as it should be, almost entirely from the physiological standpoint, only so much attention being given to form as is necessary for an understanding of function. The use of scientific terms is also very restricted.

The most interesting feature of the book is the choice of material for study. The plants are chosen almost entirely from cultivated crops which must already be more or less familiar to the pupils. As the author points out in his preface, the study of soils and of plants of agricultural importance is at least of equal value, as a means of developing the intelligence, to that of the study of plants and animals which are not of economic value to the farmer. This feature is one which, it seems to me, should be strongly emphasized in preparing any text-book of Rural Science to meet Indian conditions, for nothing is in India perhaps more striking than the fact that the book of nature is a closed one to the Indian raiyat, with the exception of those few chapters which deal

with plants and animals of economic importance to him. It is therefore essential that any instruction in Rural Science, whether practical or theoretical, should begin with those natural objects which are already familiar to the raiyat's children. The reviewer believes this principle should be emphasized in all school garden work as well.

Directions for practical observations are given at the beginning of each chapter and the simple experiments described in the book are so devised as to require very little expense in the purchase of apparatus. In a text-book suited to Indian conditions the practical and observational side would have to be more strongly emphasized than is the case in the book under review.

The style of the book is simple and direct and in every way it can be recommended as a useful model for study on the part of all those who are interested in the development of rural education in India.—(L. C. C.)

* * *

EVAPORATION IN THE CANE AND THE BEET SUGAR FACTORY, BY EDWARD KOPPESCHAAR. -Price, 7/6 net. (Published by Norman Rodger, International Sugar Journal, London.)

THIS book should prove a valuable acquisition to many who are interested in evaporation. It is concise and simple, the tables and formulæ which are excellently arranged will be useful to the managers, engineers and chemists of sugar factories, as well as to students.

The chapter touching upon the historical development of evaporation should be particularly interesting to those connected with the Sugar Cane industry in India where an enormous quantity of sugar is still prepared by very primitive methods.

The Study of Steam, Transmission of Heat, Incondensible Gases and Their Elimination, etc., are all dealt with in a condensed and practical way.—(W. H.)

* * *

The Indian Poultry Gazette, which first appeared in June 1913, is the monthly official organ of the Indian Poultry Club, Lucknow,

instituted in 1910, under the patronage of the Viceroy. The first 9 issues give promise that the Gazette will be of very considerable utility to Indian poultry breeders. It contains the usual class of information on poultry matters, hints to beginners, notes on common diseases, queries and answers, articles on breeds and other topics, descriptive articles on well-known poultry farms in England and India, etc. Such information, with special reference to Indian conditions, is not easy to obtain elsewhere and together with the advertisements makes the Gazette well worth the subscription of Rs. 3 per annum.

We wish the Club every success in its new venture.—(A. C. D.)

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THE AGRICULTURAL JOURNAL OF INDIA

AGRICULTURAL RESEARCH INSTITUTE, PUSA

PUBLISHED FOR

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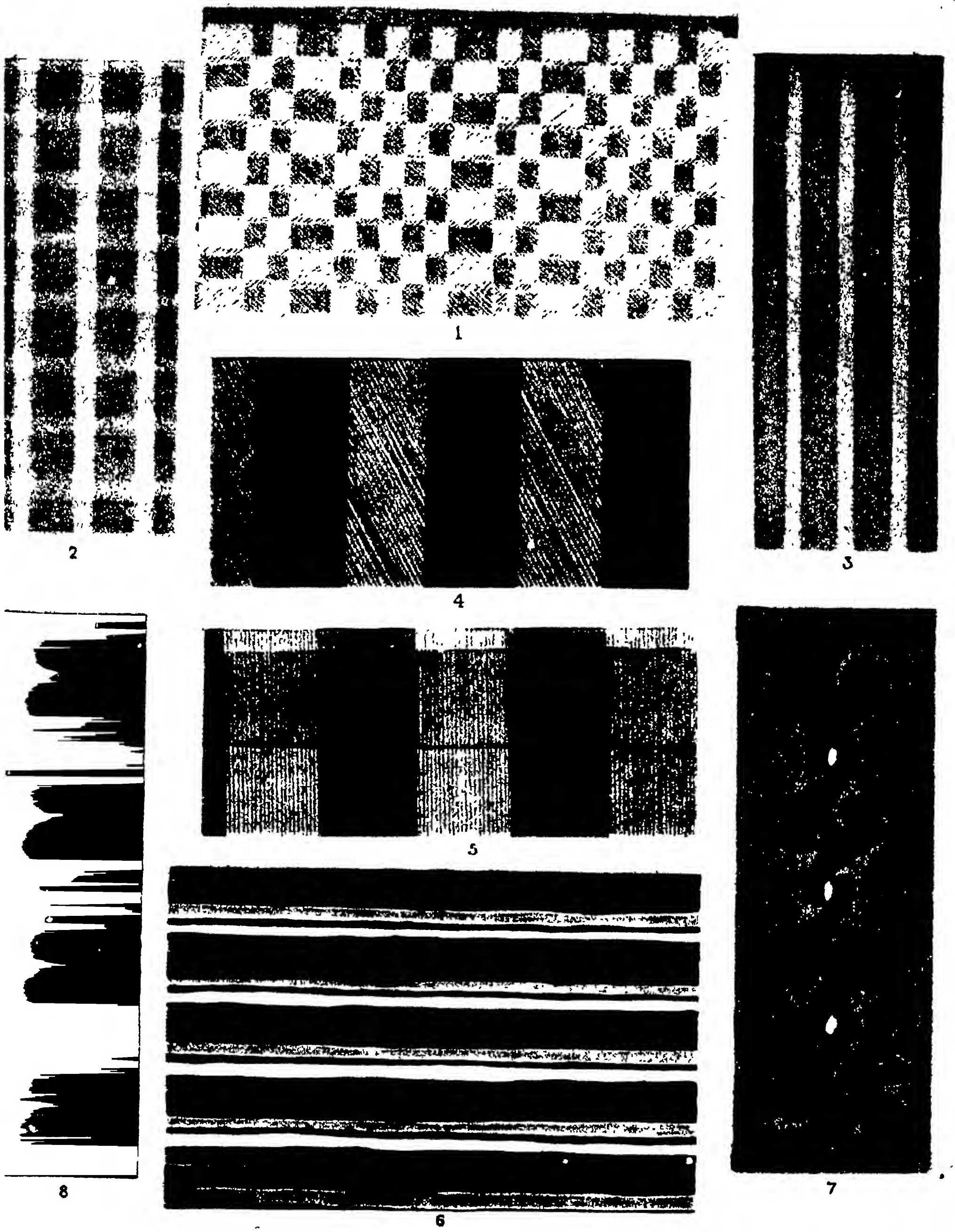


BURMA SILK PATTERNS.

DESCRIPTION OF PLATE XIX.

Fig. 1. Kaung-gin-sat.

,, 2. Bala pattern—Asein-nu-gwet.

,, 3. ,, —Pan-nu-zin.

,, 4. Saunda-sat.

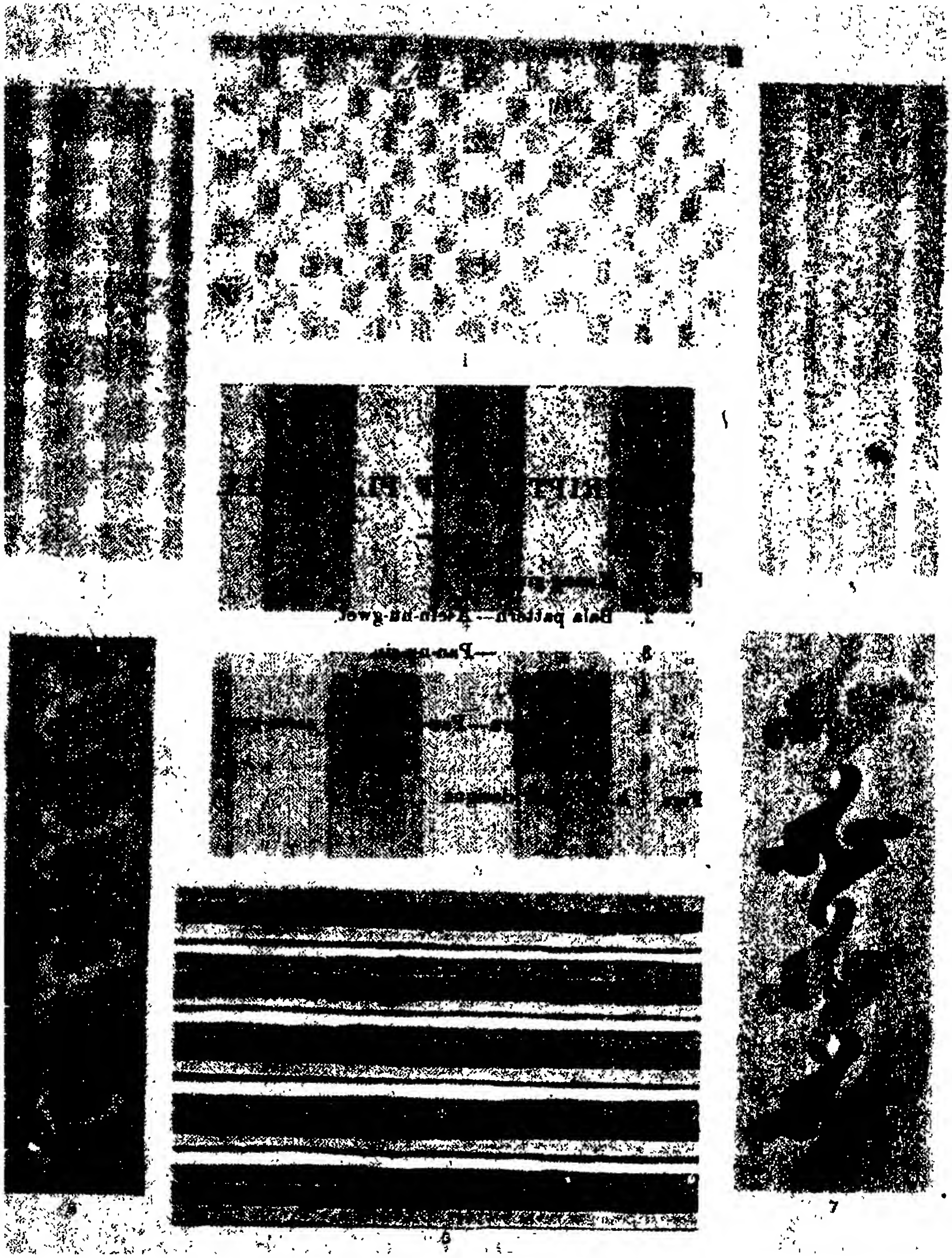
,, 5. Bala pattern—Pan-nu-pan-yin asein-gwet.

,, 6. Sat design.

Figs 7 & 8. Gaik designs.

varies greatly in different years, and in different parts [illegible] Provinces. In a good year such as [illegible] compared favourably with [illegible] conditions were exceptional and taking the mean [illegible] to another, it certainly falls short of the Java average which, for the five years ending 1912, is quoted at about 12·50 on 100 parts of cane. Owing, too, to the quantity and nature of the fibre, the cane of these Provinces is more difficult and expensive to work in the factory. Our cane, therefore, if obtainable at the same prices as in competing countries, would be relatively dearer; and the higher cost of the raw material must,

PLATE XIX



BURMA SILK PATTERNS.

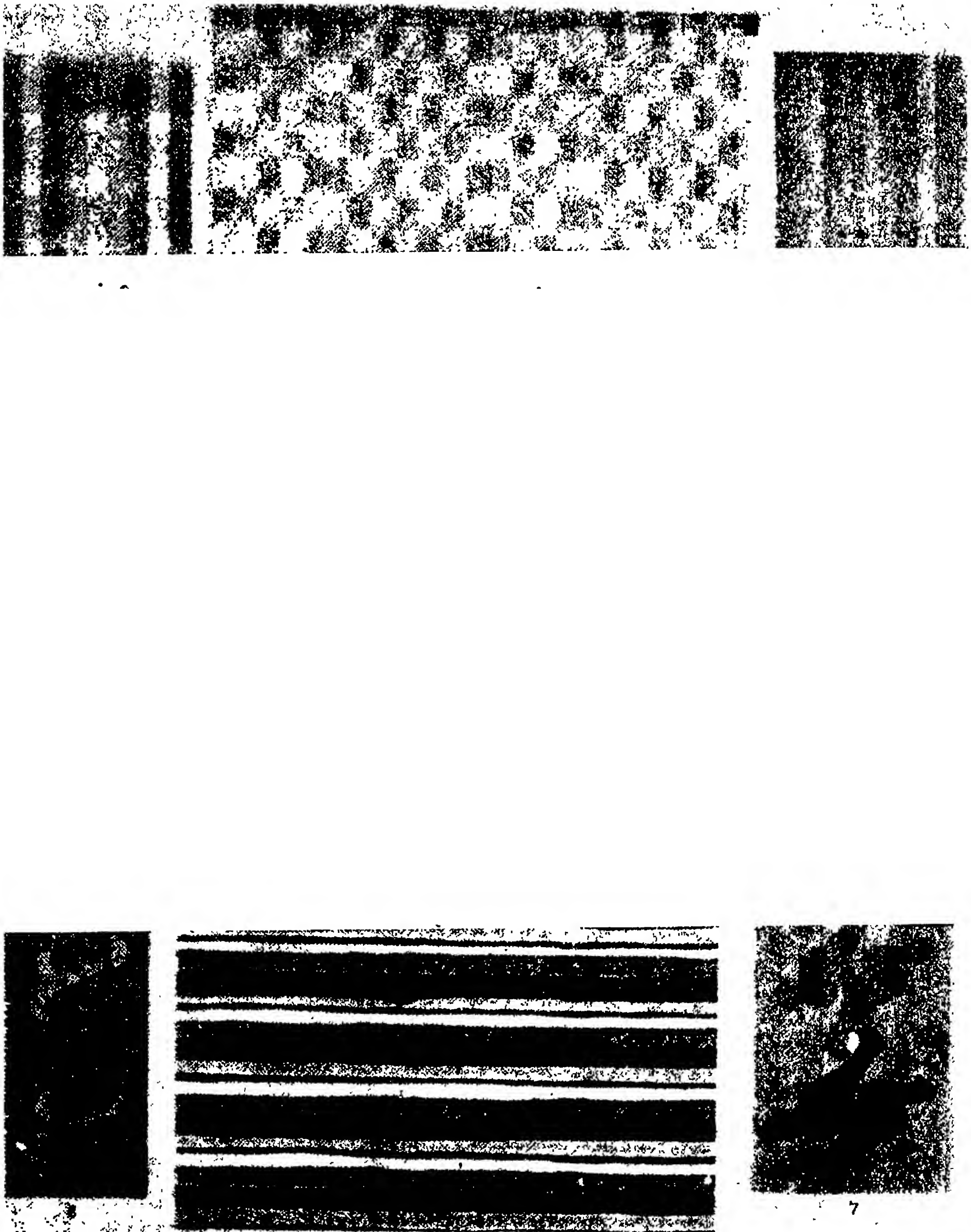
PRICES OF *GUR* AND CANE IN THE UNITED PROVINCES.

CORRIGENDA.

SUBSTITUTE the following for the existing entries in the column of "author" under the List of Agricultural Publications, Vol. IX. Part II of this Journal :—

Item 66	... F. J. F. Shaw, B.SC., A.R.C.S., F.L.S., Acting Government Mycologist.
,, 67	... William McRae, M.A., B.SC. and F. J. F. Shaw, B.SC., A.R.C.S., F.Z.S., Government Mycologists.

varies greatly in different years, and in different parts of the Provinces. In a good year, such as 1912-13, it probably compared favourably with that of other countries; but these conditions were exceptional and, taking the mean from one year to another, it certainly falls short of the Java average which, for the five years ending 1912, is quoted at about 12·50 on 100 parts of cane. Owing, too, to the quantity and nature of the fibre, the cane of these Provinces is more difficult and expensive to work in the factory. Our cane, therefore, if obtainable at the same prices as in competing countries, would be relatively dearer; and the higher cost of the raw material must,



BURMA SILK PATTERNS.

PRICES OF *GUR* AND CANE IN THE UNITED PROVINCES.

BY

H. R. C. HAILEY, I.C.S.,

Director of Land Records and Agriculture, United Provinces.

In an article appearing in this Journal for July 1913, Mr. Clarke drew attention to the average prices paid for cane at the factories of countries competing for the Indian sugar market, as shown in Mr. Geerligs' book on the "World's Sugarcane Industry." For convenience these may be reproduced. In Java the net cost of cane, without cutting and carting, averages about 2½ to 3 annas per maund. In Mauritius, when purchased from a cultivator, the average price of cane delivered at a factory is equivalent to about 5 annas per maund; and in Formosa to about 4½ annas. It is becoming increasingly clear that the future of the sugar industry in Upper India will depend largely on the prices at which cane can be procured at the factory. The average per cent. sucrose in canes of the United Provinces has not yet been fully worked out. It varies greatly in different years, and in different parts of the Provinces. In a good year, such as 1912-13, it probably compared favourably with that of other countries; but these conditions were exceptional and, taking the mean from one year to another, it certainly falls short of the Java average which, for the five years ending 1912, is quoted at about 12·50 on 100 parts of cane. Owing, too, to the quantity and nature of the fibre, the cane of these Provinces is more difficult and expensive to work in the factory. Our cane, therefore, if obtainable at the same prices as in competing countries, would be relatively dearer; and the higher cost of the raw material must,

in proportion to its inferiority, reduce the advantages to be gained from manufacturing on the spot. Another serious handicap is the comparative shortness of the crushing season. This means a high capital outlay to deal with the cane poured in during a few months of the year, and an idle plant for the remaining months.

The prices at which cane will be sold are ultimately dependent on the price of *gur*; since it may be assumed that the cultivator will only sell his produce in the form of cane, provided he can obtain at least the same profits by its disposal in this manner as from its conversion into *gur*. An attempt, therefore, has been made to ascertain at what prices cane should sell in order to give the same direct profits as are at present realised from the manufacture and sale of *gur*.

The eqnuiry has a further interest, owing to the very marked local differences in the prices of *gur*. These are due to a variety of causes, the chief among which are proximity of big markets, the quality of the cane and the skill of the manufacturer. As a consequence of the high prices realised from *gur*, there are certain definite tracts of the United Provinces where the manufacture of sugar is unlikely, unless there is a change of taste for sugar in preference to *gur*, to supersede the manufacture of the latter. Such tracts may be ruled out of any schemes for starting sugar factories.

It has been calculated that at the outside one-fifth of the cane crop of these Provinces, the area of which last year amounted to one million and three lakhs of acres, is made into sugar, and the balance into *gur* (the small area under *pounda* or chewing cane being neglected). In parts of the Provinces where the indigenous sugar-making industry is still carried on, the cane is not converted by cultivators into *gur*, but the "ras" (juice) is sold to the *khandsaris* who make it into *rab* from which sugar is refined. Since in these tracts there is a commonly accepted proportion of juice to weight of cane, there is an existing basis for calculating the rate of cane per maund which would be readily understood by the grower, and on which he would found his own calculations as to the price he should receive. The custom, however, of selling the product of the cane as *ras* is not widespread, and, in most parts of the

Provinces where sugar-making is carried on, the growers themselves manufacture the raw material for sugar refining. The inquiry must therefore primarily be concerned with *gur*; though the rates inferred from the current prices of *ras* will be useful as an index of comparison.

In analysing the costs of *gur* production it is unnecessary to take into account the costs of cultivation, cutting and stripping. These are identical whether the cane is grown for sugar, or *gur*-making. To arrive at a parity of profits from sale of *gur* and cane, it is necessary to ascertain costs of manufacturing the cane into *gur*. When these are deducted from the gross receipts realisable from the sale of *gur* manufactured from a given unit of cane, the balance may be taken to represent the market value of the cane to the grower.

But the subject presents the difficulties ordinarily encountered when any question of the expenses incurred by the Indian cultivator arises. There is a material difference between actual cost, *i.e.*, the expenditure which would be incurred by a contractor, and that of a cultivator. The former would have to hire cattle and employ labour for each branch of the work: the latter gives his own labour and that of his cattle; and, if their value were estimated at current rates, many agricultural operations would apparently be conducted at a nominal profit, or even at a loss. A strict calculation should include some depreciation on the cattle employed; but this is a nicety unlikely to appeal to the cultivator. The point is to ascertain the price at which the cultivator should be prepared to sell his cane instead of converting it into *gur*; and it is unnecessary to look beyond his actual out-of-pocket expenses. Mr. Hadi in his book on the "Sugar Industry of the United Provinces" estimated the total cost of manufacture with hired labour and cattle at about Re. 1 per maund of *gur*. This estimate was made some years ago, and since then prices have risen considerably. Experiments made at two Government farms in different parts of the Provinces, the cost of bullocks being reckoned at the current rate of the district, showed that the cost of crushing 100 maunds of cane and converting it into *gur* was between Rs. 11 and 12. The cultivator,

however, rarely hires cattle and performs some of the labour himself. A few families club together and hire a crushing mill which is worked by their oxen in turn. The juice is boiled in pans, generally hired for the season. The outlay, therefore, of the individual cultivator is for his share of the crushing mill and boiling pans, additional labour and a few miscellaneous expenses. Cost of marketing may also be ignored, as for this too the cultivator uses his own cattle.

Inquiries made in different districts through *kanungos* and *patwaris* go to show that the actual outlay of a cultivator in crushing 100 maunds of cane and converting it into *gur* varies from Rs. 3-4 to 4-8 ; the difference depending mainly on the amount of labour employed and wages paid. The crushing of the cane and boiling of the juice employs four persons, of whom two, who undertake the most responsible work, are usually adults. The hours worked are long, and one or sometimes two additional men are employed. The wages paid are four annas per diem, though, in parts of the eastern districts, a lower rate of 0-3-0 still obtains. The time taken in crushing the cane is about three and a half days ; where wooden and stone-crushing mills are employed it would be considerably longer. The hire of the mill during this period is from Rs. 1-12 to 2 according to the class hired. Hire of the boiling pans is about 0-8-0, and there are a few small miscellaneous expenses which may be put down at 0-6-0. As a basis for calculation, which at best can only be a rough one, Rs. 3-12 may be taken as an average expenditure.

To complete this calculation, the average percentage of *gur* to cane obtained by cultivators is required. On this point the returns from the farms of the Agricultural Department, the outstanding feature of which is the high percentage of extraction obtained from well adjusted three-roller Nahan mills, are of assistance only as a general guide. They serve, however, to indicate that some of the figures, hitherto published, are overestimates, if regarded as cultivators' returns. Both the farm reports and crop-cutting experiments point to the highest percentage being obtained in the Meerut division ; and these

results are justified by the superior varieties of cane grown, the better facilities for irrigation, and the more efficient mills employed. This tract may be left out of consideration; since, for reasons which will subsequently be explained, it is unlikely under present conditions that a factory would be established in it. Over the rest of the Provinces there are large areas of unirrigated cane; and in the east and south-east primitive methods of expression by means of wooden and stone-crushing mills are still in vogue. Crop-cutting experiments point to an average of about 8·50 per cent. of *gur* to cane on both irrigated and unirrigated tracts. Mr. Clarke has kindly supplied me with figures from an eastern district of the Provinces giving the same percentage over a series of years. These determinations were made under favourable conditions with efficient crushing plant. As an all-round figure for the Provinces, excluding the Meerut division, a percentage of 8·50 should be a safe estimate in the sense that it is probably rather an over-estimate of actual average results.

On the above assumptions, which it must be repeated can be regarded as nothing more than approximations, the relative prices will stand as follows:—

	Rs.	A.	P.			A.	P.	
When price of *gur* is	5	0	0	Per standard maund	price of cane should be	6	2·4	per maund;
	4	8	0	,,		5	6	,,
	4	0	0	,,		4	10	,,
	3	12	0	,,		4	6	,,
	3	8	0	,,		4	2	,,
	3	4	0	,,		3	10	,,
	3	0	0	,,		3	5·7	,,
	2	12	0	,,		3	1·7	,,

These rates may now be compared with those inferred from the current rates at which *ras* is sold. In Rohilkhund there are two sets of rates—the one when the *ras* is sold at harvest time on what is known as the " khush kharid " system; and the other when it is sold on the advance, or "dadni " system. The rates under the former sytsem are quoted as from Rs. 40 to 45 per hundred *katcha* maunds. These maunds are complicated and vary within near localities; but the measure, sometimes known as a *karda*, is equivalent

to about 62½ standard maunds. The above rates are largely nominal and it is difficult to obtain any definite figures. At the quoted rates, *ras* would be selling from Rs. 64 to 72 per hundred standard maunds; and since the *khandsari* obtains some 6·65 per cent. of sugar from the *ras* there would be little or no profit on the transaction with sugar at its present price. In actual practice the *khandsari's* transactions are carried on under the advance system, under which the price is Rs. 30 per hundred *katcha* maunds or Rs. 48 per hundred standard maunds. (Mr. Hadi writing some years ago quoted the price of Rs. 45 per hundred maunds). It is this system which has kept the industry alive in Rohilkhund. In the Upper Doab the wealthier cultivators refuse to take advances and the sugar-making industry has greatly decayed.

When cane-crushing factories were opened in Rohilkhund it was necessary to offer some inducement to the cultivator to abandon his time-honoured methods of disposing of his produce and rates appear to have been fixed on the " khush kharid " basis. It is commonly assumed that the weight of juice expressed is equivalent to about half that of stripped cane; and with *ras* selling at, say, Rs. 42 per 62½ maunds, this would work out to slightly over 0-5-0 per maund of cane. Five annas may be taken to be the general rate paid per maund of cane in Rohilkhund; separate arrangements being made for transport according to the distance. Such a rate is distinctly to the advantage of the cultivator; since he not only obtains the advance, which is essential to his system of cultivation and the prospect of which is one of the main attractions of cane-growing, but he is saved the expense of crushing his cane. As the *khandsaris* insist on the cane being lightly crushed so that the megass may burn better in the furnace and the cost of additional fuel be avoided, the assumption that 50 per cent. juice per weight of cane is generally obtained is probably also in the cultivator's favour. Experiments show that the average percentage of juice expressed by the cultivator, outside the Meerut division, is about 48·75 per cent.

With *ras* at Rs. 30 per 62½ standard maunds the price of cane would be 0-3-9 per maund; the average price of *gur* in

Rohilkhund is Rs. 3-8 per maund ; the cultivator is therefore doing much better if he can sell his cane to the factory at 0-5-0.

In the Bulandshahr district in parts of which sugar-making still survives, the rates of *ras* for the last 3 years averaged Rs. 58, 55 and 61 per 100 standard maunds. Advances are not taken and the cultivator, if dissatisfied with the prices offered, will convert the juice into *gur*. The rates, therefore, which are strictly competition rates, would, on the assumption abovementioned as to the ratio of juice expressed to cane, give about 0-4-9 per maund of cane. The district, though in the Meerut division, is a cotton rather than a cane-growing one, and the varieties of cane grown are inferior to those of the rest of the division and prices of *gur* lower. The mill efficiency, which in these Provinces is largely a matter of the class of bullocks employed, is as high. Taking the average price of *gur* as Rs. 3-12 per maund and the percentage of *gur* to cane as 9 per cent., the price of cane should be about 0-4-9 per maund.

It must of course be obvious that the strain on the cultivator's resources is much higher than is represented in the above estimate. The cultivator is not merely using his cattle to crush his own cane : he is using them to crush his neighbour's as well. All this time both he and his cattle could in most cases be more profitably employed on the land. It is not a slack season, for, outside the canal districts, irrigation of the *rabi* crops is going on all the time ; and land is being prepared for next year's cane crop. The pitiable condition of the oxen at the end of the crushing season tells its own tale as to their loss in value.

Turning now to the range of prices ; it must be pointed out that the published returns merely show the wholesale prices at the principal market towns. They give little indication of the prices obtained by the cultivators—which alone can affect the price of cane—and are for the good classes of *gur*, consumed by the middle class population of large towns, of which very little may be produced in the particular district. The village prices are unpublished and not easy to arrive at, though the ordinary cultivator has a surprising memory for the prices obtained for some years back.

Generally speaking, the *gur* of the Meerut division realises the best prices. This is due to the better classes of cane grown; the skill of the manufacturer in turning out a firm, crisp, light coloured article, and the proximity of the Punjab market. The broad shallow pan is in general use and great care is taken in clarifying the juice. In 1912-13, the districts of this division, with an area under cane of $3\frac{1}{2}$ lakhs of acres, exported just under 20 lakhs of maunds of *gur*—approximately half the total provincial exports—the bulk going to the Punjab which takes the cream of the provincial *gur*. The best class realised as much as Rs. 5 per maund; but the ordinary price for a good *gur* was Rs. 4-8 and 4. The tract next in importance is Rohilkhund which in 1912-13 exported $5\frac{3}{4}$ lakhs of maunds, principally to Rajputana. The product of this tract has not the same reputation as the Meerut *gur*. The colour is darker and the consistency inferior. Some of the canes have a higher percentage of impurities; and the custom of cutting the cane before ripe is forced on the grower by the poverty of his cattle and the claims of other crops. The thin deep pan is commonly used, in which it is difficult to avoid overheating and caramelization, and the same care is not taken in making the *gur* as in the Meerut division. Prices rarely exceed Rs. 4. Last year good *gur* sold on an average at Rs. 3-8: this year the price is lower. The average price for good quality *gur* realised by the cultivator may be put at Rs. 3-8; but there is a considerable proportion of inferior qualities turned out, and possibly the cultivator is not losing so much as might appear at first sight from selling his *ras* at the equivalent of 0-3-9 per maund of cane to the *khandsari*.

The position in Oudh is somewhat similar; except in Bara Banki district, where a superior class of *gur* is produced which largely finds its way into the Lucknow Bazaar. The Gorakhpur division in the south-east of the Provinces supplies the cheapest form of *gur*, which is mainly consumed in the Provinces, or taken by the *gur* refineries on account of its low price. No less than ten lakhs of maunds were exported in 1912-13 to other districts of the Provinces, of which nearly one-third went to the Cawnpore refineries. The price is invariably low, rarely exceeding Rs. 3 and falling as low

as Rs. 2-12 and 2-8. In 1912, prices fell to such a point that it did not pay to manufacture the cane into *gur* and some of the crop was fed to the cattle. As a general rule the *gur* is badly made, and is often a sticky mass containing an appreciable percentage of fibre and mud. That made from the wooden crushing mills, either from the bacterial action set up or the extraneous matter which finds its way into the mill, is particularly poor.

It will be apparent from the above brief résumé of prices in different parts of the Provinces that a central factory would stand little chance of success in the Upper Doab, where there is a well established and profitable export trade in *gur* and the price of cane would probably be prohibitive. The same might apply equally to the Bijnor and Bara Banki districts. On the other hand, there are parts, where in the present conditions of the *gur* trade, a factory might have a fair chance of success ; while in the south-east it would probably be a boon to the cultivators in providing a steady market for their cane, and a more profitable means for its disposal than by converting it into *gur*. If there is a profit to the refiner, who has to transport his raw material long distances by rail and employ an expensive fuel in refining, there should *primâ facie* be openings for properly equipped cane-crushing factories on the spot. As the surplus of *gur* and country made sugar available for export, after satisfying local consumption, from this trade block amounted to some 17 lakhs of maunds, there should be no lack of cane.

In dealing with the *gur* question, it is perhaps not always realised what an appreciable proportion consists of inferior qualities of dark or greenish colour and poor consistency, which is sold in the country bazaars at prices that can hardly pay costs of production. Sometimes this may be due to disease, unripeness or impurities of the cane, but there can be no doubt that an enormous quantity of good cane is wasted owing to the inefficiency of the plant employed, and to lack of skill. Even the best class of cultivators often fail to turn out a good quality *gur*, and attribute their failure to such causes as the prevalence of east winds, etc. When estimating the rate at which cane can be sold to a factory on the

basis of the prices of *gur*, the low prices must be taken with the high. The better utilization of the raw material in *gur*-making, by means of introduction of mechanical means of crushing and less wasteful methods of boiling, presents a problem separate and apart from that of the establishment of central factories ; and it is on these lines that the Sugar Engineer is at present experimenting. In any case it looks as if a change in present methods must be forced on the cultivator by lack of bullockpower, resulting from the rise in price of cattle. Sooner or later it will be brought home to the cultivator that cane crushing is an uneconomical way of using up his bullocks which at the present time cost so much to buy and feed. In well irrigated districts especially, the imperative needs of agriculture demand that some relief should be given from the strain, now imposed on the cattle, of from two to three months' continuous work of a most trying character. The only feasible remedy appears to be in the abandonment by the cultivator to a larger extent of the task now undertaken of working up the raw material.

SOME ASPECTS OF THE DANISH DAIRY INDUSTRY.

BY

H. E. ANNETT, B.Sc. (Lond.), F.I.C., F.C.S.,

Agricultural Chemist to the Government of Bengal.

THE writer of this article recently spent some time working in Copenhagen and was by the kindness of certain officials given every opportunity of looking into some of the Danish methods of organisation in agriculture. Whatever work is done in Denmark is taken up thoroughly and perhaps the qualities of that nation are as well brought out in the management of their dairy trade as in any other industry. A short description of their methods will doubtless interest certain readers in India.

One is forced to admire the Danes for the way they have struggled successfully against great odds. As a result of their war with Prussia and Austria in the sixties, they lost Schleswig-Holstein, the fairest of their agricultural provinces. Of the country remaining to them, a large proportion consisted of moor or barren sand. Up to this period corn had been the chief product of Denmark, but after that it suffered a large fall in price. Hence one can easily see that Danish agriculture was in a very bad way.

The Danes immediately set to work to make the best of the land still left to them and began by reclaiming the moor lands and sandy dunes and marshes. The reclamation work was started by Colonel Dalgas, who in 1866 founded the Danish Heath Society, with the object of bringing certain of the barren areas into cultivation. As a direct result of this Society's work, 25,000 acres of sandy land have been transformed into good soil, and 75,000 acres have been planted with conifers, while hundreds of demonstration fields have been established throughout the heath land.

In speaking of the rise of Danish agriculture, one must not omit the name of Mr. N. I. Fjord, who might perhaps be styled the Lawes of that country. He began his experiments in 1865 and founded what the writer believes to be the soundest set of practical feeding experiments which have ever been carried out. An account of these will be contributed to this Journal later.

The Butter Trade.—In the present article it is not proposed to write a full account of the Danish butter industry but mainly to give a brief account of the admirable way in which it is controlled by the State. Its importance may be gathered from the fact that, in 1907 Denmark exported butter to the value of more than £10,000,000. Most of this went to the British Isles. It is not surprising that having established such a valuable export trade the Danes should have taken great care to preserve it. We will now see what steps the Danes took to ensure their exported butter being of the highest quality. They established a most elaborate butter control system, the head-quarters of which form a section in the Royal Veterinary and Agricultural Institute, Copenhagen. This Institute was founded in 1888, and cost originally just over £8,000. Later on it was enlarged by the addition of a bacteriological section and animal physiology section, and a special section for the control of the butter industry. This meant an additional expenditure of £14,000. The Institute receives an annual grant from the State of £7,200. The Director of the Institute is Mr. N. O. Hofmann-Bang, who, like all Danish people, was most obliging. Most of the information in this article was obtained from him and from Mr. Petersen Langmack, the Inspector of the Institute.

There are 1,500 co-operative butter factories in Denmark, and every pound of butter made in the country is made in these factories. It is enacted by law that all milk, whether separated or whole, which is to be fed to cattle or pigs, must be pasteurised at 80°C, and the law imposes a heavy penalty in detected cases of transgression of this law. One of the duties of the Agricultural Institute is to test samples of milk by means of the official paraphenylene diamine test, in order to see that it has been pasteurised at 80°C.

The object of this legislation is to prevent the spread of tuberculosis. It is said there is less of this disease in Denmark than in England or Germany. It is interesting to note that if the milk is to be used for human consumption it need not be pasteurised.

The Danes thus jokingly inform the visitor that Government allows them to spread tuberculosis among themselves and their families, but will not allow them to do so among the pigs and cattle. One cannot help being amused at the statement, but the origin of the matter is not, as might be supposed, a difference of opinion as to whether bovine tuberculosis is transmittible to human beings, but is due to the fact that Denmark has so many co-operative societies for animals that they take care of their own interests, more than the State does of the health of the people.

As a result of the above enactment some dairies pasteurise the whole milk: others pasteurise only the cream. Pure cultures of souring bacteria only are used and the cream is churned after a day. The butter is packed at the factories in wooden barrels, each of which holds 51 kilograms, or roughly 1 cwt. We now reach the stage at which the control work of the Agricultural Institute begins. Each dairy is supplied with a stock of labels and a number of barrel staves by the Institute. The labels are of a particular form and are pasted on the top of the butter in the barrel. They cannot be removed without destruction. A Government stave is also put into each barrel, the barrel being made up incomplete by one stave specially for this purpose. The labels and staves are marked with the Danish Government mark and the words "Danish Butter." Further the labels and staves bear a number by means of which the name of the dairy producing a particular barrel of butter can always be traced.

Samples of butter are continually being examined at the Agricultural Institute at Copenhagen. Any butter factory is liable at any time to receive a telegram from the laboratory with a request for the despatch of a barrel of butter for examination. The butter must be despatched immediately. Thus it is ensured that the factory does not make special butter for the test, as the date of

despatch can be so well established. There are too many people working in a factory to allow of fraud being practised, and the penalties for frauds of this description are extremely heavy. Good dairies only have to send samples perhaps two or three times a year, but those whose butter has come under suspicion may have to send samples more often. The laboratory having received the samples of butter, stores them in a room at about 10°C for a fortnight. This is to allow about the same time as would elapse, if the butter were exported to England. So the keeping quality of the butter is thus also tested. Immediately on receipt of the butter sample and before storage its water content is determined. If more than 16 per cent. water is present the butter is returned to the factory without further ado, and the Government labels and staves at the factory are all forfeited. Without these the butter cannot be exported and has to find a local and poorer market. It can therefore be easily understood that the factories have every incentive to produce high class butter. In this connection the following amusing case may be related. A sample received from a certain factory contained more than 16 per cent. of water, the factory was informed and its manager immediately sent a sack and a letter to the laboratory, asking the authorities to kindly pack the "black devil" in the sack as he did not want his neighbours to know his butter was returned. As a rule the butter contains about 14 per cent. of water. At the end of the fortnight's storage the samples are judged. Each barrel of butter is examined by nine judges working in three groups of three. Each group of three judges has a separate room, and each sample of butter goes through the three rooms in turn. During the judging each barrel is covered with an iron canister so that the judges cannot see the number of the factory from which the sample comes. The butter is judged by taking out a core with an auger, and smell, texture, colour, taste and water content are taken into consideration in judging. They have a scale of points, the maximum being 15. In order to come up to exportation standard the butter must get 5 points. If this standard be not reached it is a serious matter for the factory concerned, as it forfeits all the Government labels and staves. If the judges give different

results, they are brought together over the sample to finally agree on marks, but it is interesting to find that serious disagreements are very rare. The laboratory, at the conclusion of each judging, informs the factories concerned of the weak points of their produce. All butter judged is purchased by the State at market rates, and after judging, is sold locally, as it has been disfigured a little. Government loses about 10 kroners (11*s.* 3*d.*) on each hundredweight barrel.

About 20 butter exhibitions are held annually at each of which, on an average, 100 samples are judged. At the end of each year a diploma is awarded to the factory manager who has produced the best butter during the previous 3 years. Certificates of Honour are also awarded to particularly successful managers. Only 14 of these certificates have, however, been granted in 25 years, hence it can be readily understood that both diplomas and certificates are very highly prized. The judges are made up of 40 representatives of the most important commercial butter houses in Denmark, who are therefore practical men, together with a number of Government dairy specialists. From this body the nine judges are selected and these are regularly changed. They get their railway expenses and 8 kroners (about 9*s.* 0*d.*) for the day from Government. They are provided with breakfast and coffee rooms. On the walls of the latter are photographs of all the judges who have ever been appointed and also photographs of all managers who have obtained Certificates of Honour.

From the above brief sketch it will be seen what a fine organisation the Danish butter control system is. Certainly it seems perfect and yet "Home Counties" in his admirable work entitled "A Free Farmer in a Free State" says that the Dutch butter control system is the most perfect in Europe. Even if this be so, it must be remembered that Holland has had the advantage of being able to model most of her methods on those of Denmark, which was the pioneer of the co-operative movement in agriculture.

The Milk Trade. Co-operative dairies selling milk, work on a large scale in Denmark. Pratt in "Organisation in Agriculture" says "in 1907 the enormous co-operative dairy, Trifolium, delivered

55,000,000 lbs. of milk and it was proposed to extend it to produce 110,000,000 lbs. of milk annually from about 12,000 cows. The capital in 1907 was £83,000."

It is proposed to give a short description of what was seen in the premises of the Danish Milk Co., Ltd., in Copenhagen. One is struck in Denmark by the evident pleasure which managers of concerns take in showing an Englishman over the premises under their control. The Danish Milk Company is a co-operative concern and it has three offices in different parts of Denmark. There are 350 members of the society and 150 of them send milk to the Copenhagen factory which was visited. The average daily yield of milk per cow works out at 20 to 24 lbs. Danish (1 lb. Danish = 1·1 lb. English).

In 1903, the Company sold 35,600,000 Danish lbs. of milk. This increased in 1907 to 51,400,000 lbs. Danish. At present they sell 160,000 Danish lbs. daily. To give an idea of the area drawn on for milk it might be stated that it chiefly comes from Sojaelland, while a small proportion comes from Falster, Lolland and Fyen. The cows, which supply the milk, undergo veterinary inspection monthly. Cows suffering from tuberculosis are removed from the cow houses. The contractors are bound to keep back the milk of sick cows even without veterinary intervention. The veterinary surgeon has to examine the cows for cleanliness especially their udders and also the quality of their food. Each contractor has to notify to the Company any cases of infectious diseases occurring among his employees and the milk from his herd is kept back till all danger of infection is past. All losses suffered by the contractor in keeping back milk on account of disease among the live stock or among his employees are made good by the Company. The Company stipulates for the use of fresh food. It is laid down that the hair of the udders, tail and upper buttocks of the cows is to be cut in the autumn before the animals are stabled for the winter.

The milk obtained for the first 4 days after calving must not be delivered. All milkers have to wash their hands before milking. From the milk pails the milk is poured into vessels which are placed

outside the cow house, the milk in the process being passed through a Ulander filter. In this particles of dirt are kept back by a thin layer of wadding placed between two fine metal sieves. The milk is next aired and cooled by running it over cylindrical refrigerators which are kept cool with ice water. The temperature of the milk having been reduced to 50°C and below, it is poured into cans provided by the Company. The cans have close fitting lids and are sealed with lead seals to prevent adulteration during transport. They hold when full 50 litres of milk. The cans are railed to Copenhagen where they are met at the station by the Company's own vans. At the dairy the temperature and degree of acidity of the milk is tested. If too acid or if the temperature be more than 12° to 14° C. the particular can is put aside and the milk used for other purposes. In this case the contractor receives a smaller amount for it. It is very rarely, however, that the milk is not up to the standard conditions. The milk must further contain 3·25 per cent. of fat. It is next weighed and poured through a fine metal sieve into large covered vessels made of platinised sheet iron. From these it is pumped through a flannel filter into a ventilating apparatus and thence into the pasteuriser. Here it is heated to 80°-90°C. and then passes through large cylindrical refrigerators cooled with ice water by which means the temperature is reduced to 4° or 5°C. From the cylindrical refrigerators the milk passes through closed pipes into large closed receptacles and thence to the bottling room which is on the floor beneath the pasteurising room. In the receptacles the milk is kept gently stirred by mechanical stirrers to prevent the cream separating. 8,000 kilograms of milk can be handled as above described in half an hour.

The Company takes every care to procure fresh and wholesome milk from healthy stock. They consider pasteurisation advisable because it would be quite impossible to exclude all stock failing at the tuberculin test. The Company do not, however, pasteurise children's milk but supply this from cows, which, by the tuberculin test, have been proved free from tuberculosis. The tuberculin test takes place twice a year and the Company expressly stipulates that the stock is not to contain any cow which has failed

at the test. If any cow should react or shew symptoms of reacting, it is immediately removed from the farm. The Company give, as one of their reasons for not pasteurising milk for children, that the process has proved detrimental to the digestibility of the milk. It should, however, be noted that the balance of scientific evidence would not be on the side of this statement. Miss Lane-Claypon's recent reports* to the Local Government Board on the effect of feeding pasteurised as against raw milk to children are decidedly in favour of the former.

With regard to the tuberculin test moreover a number of cows though failing at the test are well able to supply non-infectious milk, provided they have the tuberculosis in the so-called "closed" form in which no bacilli are secreted from the system.

We have so far followed the milk through the factory to the bottling room. A certain amount is now sold direct in tin cans to retail merchants. Most of it, however, is put up in bottles for sale either wholesale or retail. The bottles are all cleaned, filled, labelled and sealed mechanically. They are placed first in a huge wheel containing a number of compartments, one for each bottle: 210 in all. The bottom of the wheel revolves through a soda solution and the bottles are thus rinsed inside and out. They are next scrubbed inside with a brush rotating at 1,600 revolutions per minute and are finally rinsed with fresh cold water. They pass upside down by mechanical transport through more rinsing water to the bottling room.

The bottles are filled at the taps whose syphons are automatically closed when the bottles are removed full. The latter are closed with porcelain stoppers made air-tight with rubber rings. The Company, however, is taking to pasteboard tops which may be discarded after use. For children's milk aluminium caps are used, made air-tight with a piece of paraffined cork which can only be

* (1) Report to the Local Government Board upon the "Biological properties of milk both of the human species and of cows considered in special relation to the feeding of infants," by Janet E. Lane-Claypon, M.D. Price 9d.

(2) Report to the Local Government Board upon the "Available data in regard to the value of boiled milk as a food for infants and young animals," by Janet E. Lane-Claypon, M.D. Price 9d.

Both reports published by Messrs. Wyman & Sons, Ltd., Fetter Lane, London, E.C.

used once. The bottles are stored overnight in a cellar kept cool by a cooling machine and are sent out, next morning by the Company's own carts. The following prices at which this milk is sold may be of interest. :—

Bottles of whole sweet milk,	1 litre	19 ores	100 ores =
" " "	½ "	10 "	1s. 1½d.

These are retail prices. A wholesale trade is also done and the milk is then sold at 2 ores less per bottle.

The Company also produces some butter, the amount varying from 1,500 to 2,000 Danish lbs. (1 Danish lb. = 1·1 English lbs.) per day. It is sold in stoneware jars containing from 1 to 10 Danish pounds and also in large quantities to wholesale dealers. The buttermilk which is also put through the pasteurisation process, is sold retail in ½ litre bottles for 7 ores. At this price it finds a ready sale.

The number of people employed by the Company in handling the milk, distributing it to consumers, etc., amounts to 153 men and 71 women besides 220 boys who help the carriers in taking the milk from the vans to the houses of the consumers. The Company employs only healthy people. In case of illness in an employee's home the physician of the Company decides how long the employee is to be kept away from work. During this compulsory absence from work the Company pays full wages to the employee.

The Company issues to each contractor a contract form with the following headings :—

(*a*) Feeding and treatment of cows.
(*b*) Milking and refrigeration.
(*c*) Delivery of the milk.
(*d*) Control and stoppage of delivery.

Under each of these headings is offered advice and stipulations are made, of which most have been mentioned in the foregoing pages.

SOME OBSERVATIONS ON THE POTASH CONTENT OF SUGAR-CANE JUICE

BY

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THE amount of molasses formation in sugar manufacture is one of the chief factors determining whether that process shall be worked at a profit or a loss. In the boiling of sugar-cane juice, as is well known, a certain amount of the crystalline sugar is deposited while another part remains in a sticky mass, which in the case of *gur* is mixed with the crystals. In the refining of sugar this sticky portion is separated by different methods from the crystals and is left as a viscous sweet liquid to which the name of molasses is given.

Now in ordinary separations of crystalline substances from solution, if that solution be merely of the pure substance the whole of the material will crystallise out on mere evaporation of all the solvent liquid. In the case of sugar-cane juice however we have not a pure solution. Sugar-cane juice consists essentially of water, cane sugar, reducing sugars, salts of various metals, among which potassium salts predominate, silica, and a small quantity of gums and nitrogenous substances. It is found on evaporation of this mixture that, while nearly always a certain quantity of cane sugar is recoverable as crystals, nevertheless, even under the most improved methods, from 10 to 20% of this sugar is always lost and is non-recoverable from the molasses. Further than this, it is a well known fact that juices, containing in the first place identical quantities of crystalline sugar, yet will furnish very varying quantities of sugar crystals when treated in exactly the same way.

In consequence of this phenomenon it is obvious that, besides the amount of actual saccharose and the process of manufacture, there must be other factors influencing the formation of crystalline sugar and molasses, and it is proposed in this brief note to discuss the probable reasons for these differences in molasses formation in juices containing the same percentage of saccharose.

Now it is well known that in cane juice there are other substances than cane sugar. From the point of view of the manufacturer these substances are waste products, and his object is to reduce the quantity present to a minimum. Chief among these substances are the reducing sugars (glucose and fructose), salts of the alkalies and alkaline earths, and to a certain extent, gums and nitrogenous substances. It was at one time thought that all these substances had a great influence on the solubility of saccharose in water, and that the presence or absence of each of them made a very great difference to the amount of crystalline sugar obtained from a solution of given concentration. In fact to each of these impurities was assigned a definite number which expressed its so-called melassigenic power, giving an idea of the extent to which the crystallisation of sugar would be retarded by the presence of that particular constituent. This view has been considerably modified as a result of work done by Geerligs in Java, to which reference will be made later.

On examination of the impurities we find that the nitrogenous constituents are mainly removed during the process of clarification of the juice and that the gums, except in special cases of disease, are not present in such large quantities as to be likely to have a great effect on the amount of sugar crystallised. In consequence it is only proposed here to discuss the so-called melassigenic power of the reducing sugars and salts dissolved in sugar-cane juice. Taking these constituents in order, we first arrive at the reducing sugars, which are very difficultly crystallisable substances of much lower molecular weight than saccharose.

In the ripening process of the cane it is probable that the reducing sugars are first formed from complex carbohydrates which are initially formed by the agency of the plant from the carbonic

acid of the air. On ripening these reducing sugars disappear, and higher carbohydrates, notably saccharose, take their place. This goes on for a certain period, the reducing sugars gradually decreasing and the saccharose gradually increasing, until at last a maximum saccharose percentage and a minimum of reducing sugar is attained. After this another change is found to take place, the saccharose gradually breaking up again, giving an increase of reducing sugars and a decrease in saccharose.

The following table will illustrate this gradual change very well. It is taken from the average of the analyses of ten plots of the variety of cane known as Khari, grown at Sabour :—

KHARI SUGAR-CANE.

Average of analyses of ten plots.

Time of analyses.	1st Nov. 1913.	Mid Nov. 1913.	1st Dec. 1913.	Mid. Dec. 1913.	1st Jan. 1914.	Mid Jan. 1914.	1st Feb. 1914.	Mid. Feb. 1914.
Saccharose	11·04	12·28	13·26	13·46	14·28	14·50	14·92	14·49
Reducing sugars. (Expressed as glucose).	2·11	1·90	1·78	1·67	1·44	1·41	1·33	1·49

This cane is known to come to maturity rather early, and these figures show that the ripening occurred principally between the first week in November and first week in January, the actual maximum of the average saccharose content and the actual minimum of the glucose content being attained by the first week in February, after which date a decrease in saccharose and an increase in glucose was remarked.

It will be seen from these figures that under this last season's conditions the lowest average glucose content was 1·33 per cent. and that the highest amount of saccharose present was 14·92 per cent. There is no doubt that this presence of glucose is a distinct disadvantage and very few cases are found in which the glucose on ripening has completely disappeared. The writer has in the course of his experience come across isolated cane clumps in which the glucose has been almost negligible, but such cases are very few and far between.

Now it was thought at one time that the presence of this glucose in cane juice had a great influence on the percentage of cane sugar available for crystallisation and the amount entering into the molasses. This idea has only recently been proved to be false by Geerligs, the great Dutch sugar chemist, who was at one time Director of the West Java Sugar Experiment Station. This observer found from a large number of observations made on cane sugar molasses in Java, that the actual ratio of saccharose to water in molasses is generally less than that of the saccharose to water in a saturated solution of pure sugar and that generally the molasses containing most glucose shows the lowest ratio of sugar to water.

Now, in existing literature glucose is nearly always referred to as a molasses former, and one would in consequence expect high solubilities instead of the low values which were found by actual analyses. In consequence Geerligs made some experiments to ascertain how glucose influences the solubility of saccharose in water and by these experiments he completely upset the old view of the molasses forming power of the former sugar.

He took a supersaturated solution of pure saccharose and added to it glucose in varying amounts and obtained the following results after some months' standing :—

	1.	2.	3.	4.	5.	6.	7.
Sucrose crystallised out ..	9·3	9·1	10·0	8·9	9·8	9·2	9·0
Sucrose dissolved ..	15·7	15·9	15·0	16·1	15·2	15·8	16·0
Glucose	25·0	12·5	6·0	3·0	1·0	0·5	..
Water	7·5	7·5	7·5	7·5	7·5	7·5	7·5

A consideration of these figures, which were carefully revised by Geerligs, shows us that the quantity of glucose present in the juice has no appreciable influence on the amount of saccharose which will ultimately crystallise from a supersaturated solution.

While these experiments showed very clearly that the presence of glucose did not diminish the formation of saccharose from its supersaturated solutions, they nevertheless did not throw light upon the fact observed, that there was actually less saccharose dissolved in certain Java molasses than would correspond to a saturated

solution of the amount of water contained in the molasses. This diminution of dissolved saccharose did not occur in every case, but it was found to happen as a general rule, as will be seen from the following table which has been copied bodily from page 305 of "Cane Sugar and its Manufacture" by Prinsen Geerligs, 1909 edition :—

No.	Dry Substance.	Sucrose. (Saccharose.)	Reducing Sugar.	Ash.	Water.	Quotient of Purity.	Sucrose on 100 parts of water.*	Ratio of Reducing Sugar to Ash.
0	..	..	..	..	..	100·	216·2	..
1	74·88	59·20	7·29	6·07	25·12	79·06	235·7	1·20
2	74·29	58·70	9·97	3·82	25·71	79·01	228·3	2·61
3	82·88	47·80	14·53	6·66	17·12	57·67	279·2	2·18
4	74·69	50·20	15·14	4·35	25·31	67·21	198·3	3·48
5	82·90	43·70	15·80	6·50	17·10	52·17	255·6	2·43
6	72·23	49·00	16·52	2·52	27·77	67·84	176·4	6·56
7	83·55	47·90	17·44	7·00	16·45	57·33	291·2	2·49
8	71·07	42·90	19·93	3·00	28·93	60·36	148·3	6·64
9	71·55	43·10	20·87	3·39	28·45	60·23	151·5	6·16
10	77·10	34·10	23·00	7·80	22·90	44·23	148·9	2·95
11	71·40	32·40	23·00	5·20	28·60	45·38	113·3	4·42
12	76·80	36·90	26·30	4·97	23·20	48·05	159·1	5·29
13	75·86	30·90	27·47	6·37	24·14	40·73	128·0	4·31
14	73·88	32·90	27·53	3·72	26·12	44·53	126·0	7·40
15	80·90	35·30	27·60	8·08	19·10	43·63	184·8	3·42
16	74·62	34·05	27·78	4·16	25·38	45·63	134·2	6·68
17	75·50	33·70	28·12	3·65	24·50	44·64	137·6	7·70
18	77·02	33·80	28·20	6·88	22·98	43·88	147·1	4·10
19	73·78	32·19	30·30	3·77	26·22	43·64	122·8	8·04
20	74·23	30·69	31·73	3·65	25·77	41·34	119·1	8·69

* At 28 C.

From this table it will be seen that the solubility of sucrose in 100 parts of water at the average Java temperature is 216·2 parts. This is put at the head of the table as number 0 in the series. Further, it will be seen that out of twenty samples analysed only 5 showed a greater ratio of saccharose to a hundred parts of water than 216·2 and the remaining ratios were far less than this. Since the glucose in solution was found to have no effect either negative or positive upon the amount of crystallisable sugar, and the remarkable phenomenon illustrated by this table was found to exist, it was necessary to look for some other factor in the juice which was likely to affect the amount of sugar crystallising out from a sugar juice. Now it is well known to chemists that certain mineral salts have a definite action, which is not very well explained, upon the

precipitation of organic substances and Geerligs was led to enquire whether the joint action of invert sugar and salts might give rise to this phenomenon of the varying quantities of saccharose dissolved in the same amounts of water in different samples of molasses. In consequence he prepared solutions containing the same amount of saccharose and water but varying amounts of glucose and of potassium acetate. The solutions of saccharose were so prepared as to be supersaturated and, after this supersaturated sugar had crystallised out it was weighed and the figures were obtained which showed that, while potassium acetate without glucose enormously increased the solubility of saccharose in water, when glucose was added to the solution this solubility was very much decreased, and that, when a high ratio of glucose to ash was found in the mother liquor, a much larger quantity of saccharose crystallised out than when this ratio was low. The ash, of course, is obtained by evaporation of the juice and subsequent ignition and may be regarded as a measure of the quantity of salts present in the juice. Geerligs was therefore led to the conclusion, which he substantiated by a very complete series of experiments, that the simultaneous presence of any kind of salt and glucose promotes crystallisation of saccharose, and that crystallisation is more abundant when for a given amount of salt, the proportion of glucose is greatest. This may be simply explained by regarding molasses as a hydrated combination of salts and saccharose, which is stable in a concentrated and only dissociated when in a very dilute state. When glucose is added to the system a certain amount of the saccharose is displaced from combination by the glucose and is deposited from solution.

Molasses then is defined, by Geerligs, as 'a hydrated combination between sugar and salts, which cannot be broken up by dissociation in a concentrated state and therefore cannot yield sucrose in a crystallised form.'

In view of these facts, therefore, it is obvious that besides the amount of saccharose and glucose in a cane juice, a very important factor in its value is the content of salts. Now of the salts of sugar-cane juice, by far the greater amount are those of potash and an estimation of the potash content of the juice will therefore

give us a very good idea of its salt content. Now these salts appear in all stages of sugar manufacture, as there is no system of clarification which will remove them, and, in consequence, their determination is a matter of considerable importance. Besides the effect of these salts upon the molasses formation it is probable, according to Geerligs, that a high potash percentage in the cane juice is as a rule accompanied by a low quotient of purity, a low saccharose content, and a high glucose content when the cane is ripe. Further. the same observer calls attention to the fact that different varieties of sugar-cane give juice containing different quantities of potash even when grown on the same soil, and that the potash content of a juice changes very little during the process of ripening -in which point this property differs from that of sugar content. During the past season a few experiments have been carried out on this subject with a view to determining whether the different varieties of cane grown at Sabour would show marked differences in the potash content of the juice. A large number of juices have been analysed after ignition, and there are indications of such differences. At the same time however differences have been observed in the same variety when grown in different fields which are quite closely adjacent, so that it is probable that a very great number of experiments would have to be made on different plots and their average taken before we could be sure that this difference in potash content was due to the variety and not to the circumstances in which it was growing. A continuation of these experiments is being made, as it is obvious from consideration of the few facts given in this brief paper that the salt content of a sugar-cane juice is of the highest importance for, as mentioned above, the amount of salts in the juice is said to influence the amount of saccharose at maturity and certainly has a great effect on the amount of sugar that will crystallise out.

It will perhaps be of interest to give a short account of the differences in potash content found both in the same variety under different treatment and also in different varieties under the same treatment.. Mention has already been made of the fact that a great amount of variation was found in the potash content of juice from

a single variety grown under different conditions. The variety which was chosen for examination was the one known as Khari, which grows very well under the conditions existing at Sabour. From the beginning of December 1913 until the middle of February 1914, fortnightly observations were made on the potash content of the juice of this cane grown on various plots. The perchlorate method of estimation was used, and although in the earlier experiments no attempts were made to remove the sulphate, it was found necessary to do this in order to render the results absolute. In consequence only those results are quoted which have been obtained after freeing the ash from sulphate with the use of barium chloride. There was, as one would expect from reading Geerligs' account, little change in the average potash content of the juice from each field during the whole season. On the other hand, however, it was found that the average potash content of the juice from one field was distinctly different from that of the other and, in fact, varied very largely between such wide limits as ·142 per cent. and ·285 per cent. These cases are extreme limits, but the existence of such differences renders it obvious that it would be difficult definitely to classify a cane as high or low in potash content on the results of a single analysis, as there appear to be many other factors influencing the potash content of a cane juice besides the actual nature of the cane itself. In consequence it is hoped that a more extended series of observations may be made in ensuing seasons.

Now on the juice of the Khari variety of sugar-cane 38 absolute potash determinations were made. About 100 determinations were done without elimination of sulphate but these have not been considered. The average potash content of the juice of these 38 samples was ·191 per cent. and the probable error of a single sample calculated from this was ·021 per cent. The samples were taken from two adjoining fields, one of which was apparently richer in available potash than the other, as the average potash content of juice from canes grown in the one was ·173 per cent. while the average potash content of juice from the other was ·208 per cent. Further, the plot immediately adjacent to the field with high potash content also gave cane with a very high percentage of potash in the juice.

Figures therefore of potash content of the juice of any one variety must be taken from the average of a great number of determinations if great reliance is to be placed on them.

The few figures obtained by this year's work also throw light on Geerligs' statement that the potash content of the juice and *its saccharine richness are to a certain extent correlated.* In the first place an examination was made of the samples of Khari cane which were examined with a view to finding out whether this correlation existed in one variety. Had this been the case it would have appeared that the actual external influences which affected the potash concentration of the cane had affected the sugar content more than the nature of the cane itself.

The mean sugar content of the 38 samples of juice was 13·79 and the mean potash content ·191. On drawing these results up in tabular form the accompanying scheme was obtained:—

TABLE SHOWING NUMBER OF SAMPLES OF THE SAME VARIETY OF CANE CONTAINING VARIOUS PERCENTAGES OF SACCHAROSE AND POTASH IN THE JUICE.

Percentage Sugar Content.

Percentage Potash Content.	9·5 to 10·5	10·5 to 11·5	11·5 to 12·5	12·5 to 13·5	13·5 to 14·5	14·5 to 15·5	15·5 to 16·5	16·5 to 17·5	17·5 to 18·5	Mean 13·79
·140–·160 ..	..	..	..	2	3	3	..	..	..	– ·040
·160–·180 ..	..	..	2	2	2	1	1	..	..	– ·020
·180–·200 ..	..	*1*	..	2	*1*	[illegible]	[illegible]	..	..	*taken as mean.*
·200–·220 ..	1	1	..	2	..	..	..	1	..	+ ·020
·220–·240 ..	..	..	1	1	..	..	..	..	..	+ ·040
·240–·260 ..	..	..	2	1	..	..	..	..	1	+ ·060
·260–·280 ..	..	..	..	..	..	..	..	..	..	+ ·080
·280–·300 ..	..	..	1	..	..	..	..	..	..	+ ·100
Mean–·191 .	–4	–3	–2	–1	*taken as mean.*	+1	+2	+3	+4	

This scheme roughly shows that there is probably very little indication of correlation between potash content and sugar content in the 38 samples examined. The actual calculation according to the usual formula shows a correlation of —·26 ± ·10 which is practically no correlation at all. It must, however, be pointed out that

such an examination, based [illegible] determinations, cannot be assumed to give more than [illegible] of what to look for, and that we can hardly say that [illegible] proves the absence of correlation. As we shall [illegible] however there is much greater evidence of correlation bet[illegible] potash and sugar content of the juice when the juices [illegible] belong to different varieties, although here again we have only a few determinations on which to base our calculations. The sugar determinations were made from samples taken at the end of February and beginning of March as at that time there is found to be little error due to immaturity or over-maturity of the cane. As was to be expected, the differences in potash content were found to be much larger from variety to variety than in the one variety examined. The mean potash content of 38 varieties was found to be ·174 and the extremes were as wide apart as ·060 per cent. and ·272 per cent. The standard deviation was + ·050. A tabular scheme drawn up in this case shows that there appears to be a distinct connection between the potash content of different varieties and the sugar content of their juice. This table is now given showing as before juice richness as abscissæ and the potash percentages as ordinates. The abscissæ are taken to pass through the group of potash content lying between ·160 per cent. and ·180 per cent. and the ordinates through the group of sugar content 17 per cent. to 18 per cent.

TABLE SHOWING NUMBER OF VARIETIES OF CANE CONTAINING VARIOUS PERCENTAGES OF SACCHAROSE AND POTASH IN THE JUICE.

Percentage Sugar Content.

Percentage Potash Content.	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22	
·060–·080				..	..	..	..	1	—·10
·080–·100				.	1	..	..	..	—·08
·100–·120				..	..	2	..	..	—·06
·120–·140				1	..	2	..	..	—·04
·140–·160				1	6	1	..	..	—·02
·160–·180				2	2	1	1	..	..
·180–·200				..	1	..	..	..	+ ·02
·200–·220				2	2	..	..	..	+ ·04
·220–·240		1	1	..	..	..	..	..	+ ·06
·240–·260		1	1	2	..	..	..	..	+ ·08
·260–·280		1	..	..	..	..	..	..	+ ·10
					+1	+2	+3		

An inspection of this scheme shows the majority of cases outside the mean to be placed either in the top right or bottom left quadrants of the table. This at the first glance indicates a negative correlation. The actual correlation figure as worked out from these data is ·47 ± ·08 which gives an indication that going from variety to variety, the potash and sugar contents are in some way correlated. We may therefore conclude that work on the potash content of cane juice is likely to be of great value in the examination of different varieties of canes. In consequence it is hoped to take up this study more fully in the near future.

THE SEED SUPPLY OF THE NEW PUSA WHEATS.

BY

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THE improvement of Indian wheat was one of the first subjects studied by the Botanical Section at Pusa. As a result of the investigations made, a number of wheats were isolated, both by selection and by hybridization, which, after repeated trials in the important wheat-growing tracts of India, proved themselves to be superior in yield, rust resistance, grain quality and standing power to the crop as grown by the people. The results obtained led to a great demand for seed, and, at the present time, the new wheats are being distributed by the Agricultural Departments of Bihar, the United Provinces, the Punjab and the Central Provinces. Preliminary trials have also given good results in Australia and British East Africa, and during the present year over 500 bushels of seed have been ordered by these countries.

A large amount of seed is required in India for the purpose of starting the various seed distributing organizations now being built up by the Agricultural Department. As any wheat grown under Indian conditions tends to become impure and to contain other kinds, both on account of natural cross-fertilization and accidental admixture, it will be necessary for the various distributing agencies to secure from time to time fresh pure stocks of any particular wheat. This process of pure seed distribution will naturally be

to go on till the wheats in any locality have been replaced entirely by an improved kind when the new variety can be left to maintain itself. Such a replacement must take time, and, during this work, it is essential that the distributing agencies should have at their command a source of well-grown seed, true to type, in considerable quantities. To provide such a supply for a country of the size of India and for organizations of such magnitude as already exist in the various Agricultural Departments, it is clear that the land at our disposal at Pusa is quite inadequate. All that can be done at Pusa is to produce improved wheats, to test them for yield and other agricultural qualities and to grow about three or four hundred bushels of seed a year. Some means of producing ten to fifteen thousand maunds of seed annually as well grown and as pure as that grown at Pusa had to be devised. Such a system has been developed and has been in working order for the last two years. This has been done at no cost to Government. As the method adopted is not without interest from the larger aspect of the improvement of crops in India, an account of the way in which seed of the new wheats is produced in large quantities is given in the present paper. The main object in the work is to supply seed in bulk to the Agricultural Department and for this purpose Government has the first call on the produce. What is not required by Government is sold to Native States and to the general public at rates which cover the cost of actually growing the seed and the extra trouble taken by the seed farms in growing high-grade wheat for seed purposes as opposed to ordinary wheat growing. No charge is made to cover the cost of creating the wheats. This must be regarded as a grant by Government towards the general improvement of the Indian wheat crop.

The Dholi and Bowarrah indigo estates in the neighbourhood of Pusa have been utilized as seed farms for the growth of large quantities of seed of the new wheats. In the season 1912-13, about 600 acres were put down in Pusa wheat. The area was increased to 700 acres in 1913-14. The seed-producing capacity of these estates is not likely to exceed 1,000 acres a year which on the average can be expected to produce about 15,000 maunds of

seed annually.* Orders for seed can either be sent to the Imperial Economic Botanist, Pusa, or direct to the Manager, Dholi Factory, Dholi P. O., Bihar.

After being tried on a field scale at Pusa and in the wheat-growing tracts of India, the new varieties are sent to England for complete milling and baking tests. Any wheats which satisfy these numerous trials are then sent to the seed farms for multiplication as seed wheat. The early wheats are as a rule grown at Dholi, the later sorts at Bowarrah, where the soil is heavier and more retentive of moisture. The greatest care is taken on both estates to grow the wheat to perfection. The crop is sown on land which has been fallowed during the monsoon and which is therefore in the best condition to produce the maximum crop of well-grown seed. A large portion of the wheat land on the estates has been drained and this work is being proceeded with as rapidly as possible. After sowing, the young crop is harrowed by means of lever harrows so as to break up surface crusts and to leave a mulch of dry soil on the surface. Before reaping, the fields are rogued and as far as possible all stray plants are picked out before the crop is ripe. This rogueing results in exceedingly uniform fields and it is not easy on these estates to find ears untrue to type. Great care is taken at harvest time and in the threshing process to avoid admixture. If more than one kind is grown on the estate, the sorts are stacked separately, the machines are cleaned out before threshing begins and the bags are stencilled with the number of the kind before they leave the machine. Any one who has seen the orderly manner in which the work of threshing the wheats at Dholi is conducted will have no doubt about the care that is taken in keeping the varieties separate. After threshing, the seed wheat is put through a dresser which takes out all the small and broken grains. The final product is a well-grown sample which would compare favourably with seed wheat sold by European firms engaged in

* These estates are managed by Messrs. Edward & Gerald Danby, who have devoted a great deal of attention during the last few years not only to the growth of wheat for seed purposes, but also to the general improvement of their estates. During the past wheat season especially, they have succeeded in producing crops on the large scale, under estate conditions, equal in yield and quality to the best that have been grown at Pusa.

similar business. From time to time, the various kinds grown on these estates are started from a new stock of selected seed grown at Pusa. In this way, the seed wheat is kept up to standard and the result of the small amount of natural crossing which takes place in Bihar is reduced to a minimum. The whole of the arrangements connected with seed growing on these estates are settled in consultation with Pusa and frequent visits are paid to the estates so as to keep in close touch with the work.

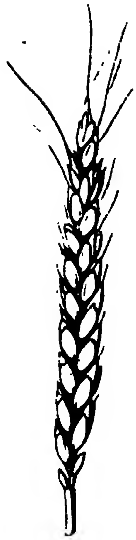
The wheats now being grown for seed are six in number and are briefly described in the following. The ears are shown in the Plate opposite.

Pusa 4.—This is a large-grained, white wheat with short stiff straw of good standing power and white, felted, beardless chaff. It has given good results as an early wheat both on the black cotton soils of Peninsular India and also in the Gangetic plain. In Bihar, Pusa 4 is suitable as a cover crop for Java indigo on account of its rapidity of growth and the small amount of foliage it produces. These circumstances allow of sufficient light reaching the young indigo plants during the period the wheat crop is on the ground. This is the earliest of the new wheats and is able to mature seed with the minimum of moisture. As regards grain quality, the bread yielded by this variety is similar to that obtained from Manitoba wheat. Pusa 4 is suitable for all tracts of Peninsular India and the Gangetic plain *where a rapidly maturing wheat is required and where the soil moisture is likely to be in defect.* In Bihar, it has a special use as a cover crop for Java indigo. On account of the size of the grain, the seed rate of this wheat should be somewhat greater than that in use in the case of ordinary Indian wheats.

Pusa 6.—A white wheat with smooth, red chaff and short, reddish awns. So far this wheat has only been tried on a large scale on the indigo estates in Bihar where it has done well. It is probable that it would also suit some of the eastern Districts of the United Provinces where the climate is damp and where a rust-resistant wheat is desired. As regards grain quality, this wheat has good milling qualities and yields strong flour. From the

PLATE XX.

No. 4.



N. [illegible].

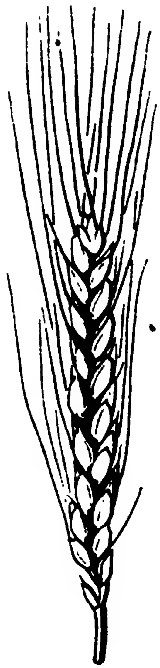
No. 7.

No. 8.

No. 12.

No. 101.

No. 106.



No. 110.

PUSA-WHEATS.

agricultural aspect, this variety has one defect, namely, a tendency to shed its grain in very dry, windy weather. On this account it should be cut before it is dead ripe when the loss of grain is avoided and the tendency to shed is an advantage in the ease and rapidity with which it can be threshed. At present, this wheat should not be purchased for growth on a large scale outside Bihar and the damper regions of the eastern United Provinces.

Pusa 7.—This is a strong-strawed, large-grained, white wheat with white, felted chaff and short awns. It has given high yields at Pusa and has maintained its yielding power in the Central Provinces. In damp years in Bihar, it suffers a good deal from black rust on the stem and on this account has not been multiplied on the seed farms. It is possible, however, that it may be more suitable in the drier wheat tracts of Central India and for this reason it will be grown on at Pusa on a small scale.

Pusa 8. A long-grained, white wheat with stiff straw and smooth, greyish chaff with short awns. This variety has given large yields of high quality grain at Pusa, but this grain quality has not been fully maintained when grown in other wheat-growing tracts. On this account and because of the brittle nature of the grains it is no longer being multiplied on the seed farms. In some tracts of the United Provinces, however, it has given very high yields and is therefore favoured by the cultivators. In general, it has not proved for general cultivation such a useful wheat as No. 12.

Pusa 12.—This is a long-berried, white wheat with smooth red chaff and long ears which are without awns. In the field, it is an attractive looking wheat and the typical red ears and smooth shining straw are characters of value in the work of replacing the country wheats by a new kind. The grain of this variety has excellent milling and baking qualities, which are not lost when the wheat is grown on the black soils of the Peninsula or under canal irrigation in the Indo-Gangetic plain. Indeed the quality improves in Central India and in the Punjab. In yield, this wheat is very satisfactory and moreover has the advantage that it will ripen with less water than types such as Mozaffarnagar. Pusa 12 is being distributed to cultivators in the Punjab, in the United Provinces,

in Bihar and also in the Central Provinces. In 1914, the 2,500 maunds of this wheat on the seed farms was disposed of long before harvest time. In 1915, it is expected that 8,000 maunds of seed will be available.

Pusa 101.—A short-strawed, white-grained wheat with smooth, white, bearded chaff. This is a hybrid, obtained by crossing one of the local Bihar wheats of good grain quality and rust resistance with Mozaffarnagar white. The result is a wheat of similar yielding power to Mozaffarnagar but with grain of good quality and a considerable degree of resistance to rust. As regards yield, this wheat has done exceedingly well in Bihar and the United Provinces where it has been grown for some years. In the present year Pusa 101 gave over thirty maunds to the acre on the light lands of the Dholi estate under strict *barani* conditions. It has however the defects of its parentage, namely, weak straw, so that a heavy crop is sometimes lodged by the violent gales which sweep over Bihar after the wheat is in ear. In spite of being somewhat easily lodged, this wheat always ripens a large quantity of good grain. So far it has only been grown in Bihar and in the United Provinces where it has done well.

Pusa 106.—A white-grained wheat with smooth, white chaff and short awns. This is a late wheat and only suitable for trial in tracts where the growth period is long. It has done exceedingly well with the cultivators in the submontane Districts of the United Provinces to which its distribution should at present be restricted. It is a hybrid obtained by crossing Pusa 6 and Mozaffarnagar and possesses the grain quality of the strong parent.

Pusa 110.—A white-grained wheat with smooth, red-bearded chaff. This high quality wheat has so far only been tried in the United Provinces and in Bihar where it has done well. Where a bearded wheat is particularly desired this kind is well worth a trial. It is a hybrid obtained by crossing Pusa 6 and Mozaffarnagar and combines the grain quality and straw of the former parent with high yielding power.

In the present stage of development of the Agricultural Department in India there are many obvious advantages in the system

of seed growing in connection with a plant breeding station such as that adopted in the case of wheat at Pusa. The system is elastic and can be extended or contracted according to the demand for seed. If the 1,000 acres on the Dholi and Bowarrah estates are insufficient to meet the demand for seed, other suitable indigo factories can be added to the list. If the demand falls off during any particular year, the area under seed wheat can be contracted and the land used for other crops if necessary. The method is based on the adaptation of existing agencies as opposed to the creation of more Government machinery. It possesses the advantage that no staff is involved and no capital expenditure for the acquisition of land and the erection of buildings is required. Further, a large quantity of seed is grown by a single agency and the expense and trouble are avoided which are inseparable from systems depending on the collection of seed at one centre from a large number of small growers.

SILK WEAVING INDUSTRY OF AMARAPURA.

BY

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I.—Brief History of the Industry.

In his interesting Monograph "Silk in Burma," Mr. Hardiman, I.C.S., writes:—

> "There is no mention in authentic historical record or local legend of the source from which the silk industry was brought into Burma, of the channel which it followed, or of the manner or date of its introduction."

On the other hand, he quotes the following from Mr. Kenny, who unfortunately does not state whence he derived the information he gives:—

> "After the conquest of Assam by Alaungpaya (1755), a large number of silk weavers were brought down as prisoners of war to Ywa-bein and Pauk-kaung, near Prome. Here apparently the silk industry was started. After the Prome people had been thoroughly well taught, the deportees were recalled to Ava and there again started the industry, instructing the local people, who readily acquired it."

The descendants of those deportees, who have permanently settled in Amarapura Sub-division, now far outnumber the pure Burmans who are engaged in the silk industry. "Locally, each centre of the silk industry in Burma," says Mr. Hardiman, "has its own account of how the industry came to it. But unfortunately none of these local accounts is more than vague and meagre and

such as they are, they rival in discrepancy the list of the 'birth-places of Homer'."

II.—Sericulture.

Though sericulture is carried on in a primitive form in some districts, the weavers have to depend solely upon foreign countries for the raw silk required by them (*vide* Tables *infrà*). The local silk is of an inferior description and unfit for the manufacture of fine fabrics, arising, as Mr. Geoghegan noticed as early as 1871-72, from the "vile" methods in practice in the rearing of the worms and the reeling of the silk.

(*a*) *Silk-worm Breeders.*—The Yabeins, a curious race, whose origin is a moot point, were almost exclusively engaged in the culture of the silk-worm up to about the middle of the second-half of the past century, when many Yabein villages gradually took to cultivation, especially in the Pegu District. They are said to have been once orthodox Buddhists, until some of them took to sericulture, and as this involved the destruction of the chrysalides, they were looked on with contempt and dislike by their neighbours. Another plausible theory is that the culture of the worm is older than Buddhism, and that it was the introduction of Buddhism which stamped them as a tribe apart who had no qualms of conscience in taking life. Or again, as Mr. Hardiman has advanced, these people may be a survival of one of the broken clans like the Danus and Danaws "of whom little except a bare name and a barer claim to a separate existence is to be gathered. They may be counted among the 'lost tribes' with equanimity." They numbered two thousand one hundred and ninety-seven persons in 1891 in Lower Burma. As stated above, not a few Yabein villages have abandoned their hereditary industry for cultivation. On the other hand, some Karens have taken to silk-worm-rearing. Sericulture was also carried on to a small extent in the Lower Chindwin, Pakokku, Magwe and Yamethin districts in Upper Burma, and in Lai Hka, Möng Sit and Möng kang in the Shan States.

A glance at the table below will show to what considerable extent the number of silk-worm breeders has fallen off in the course of the two decades beginning with the year 1891.

TABLE I.

District.	Number of breeders, including males and females in 1891	1911
Prome	1,603	125
Henzada	21	—
Tavoy	2	—
Toungoo	776	78
Mandalay	2	—
Shwebo	7	—
Lower Chindwin	70	—
Pakokku	32	—
Magwe	279	3
Yamethin	310	5
TOTAL	3,102	211

As the number of the silk-worm-rearers has decreased steadily during the twenty years under review, no separate figures touching this industrial class have been shown in the Census Returns of 1911. They were lumped with the "breeders of small animals," such as poultry rearers, apiculturists, etc. Thus, the figure 211, though conjectural, gives us workable data, as it bears the stamp of reasonable probability from the fact that out of the total of "breeders of small animals" in 1911, *viz.*, 1,459, two hundred and eleven persons worked in the districts where sericulture was almost exclusively, if not solely, the industry of those who would be classed under the head "breeders of small animals." It may then safely be assumed that the majority of the 211 persons are silk-worm-breeders. The comparative figures for 1891 and 1911 show that the industry bids fair to die out completely at no very distant date.

(*b*) *Causes of the Decline of Sericulture.*—A careful analysis on the spot of the conditions obtaining with regard to this branch of the silk industry in the districts named, will go to show that the figures are a credible indication of the resultant effect of various adverse but avoidable factors operating towards the rapid and serious decline of the industry. The main causes may be briefly summed up as follows :—

(1) The crude and careless system of rearing and inter-breeding, and consequent degeneracy of the breed ;

(2) The ravages of diseases;

(3) The imperfect knowledge of the reeling of the silk and the consequent production of coarse, uneven thread, more or less unsuitable even for local consumption and markets, and *a fortiori*, for foreign export.

It cannot certainly be said that the Buddhistic prejudice against any industry which involves the taking of animal life, is less strong now than it ever was in the past, hence this, with the gradual secession of the Yabeins from their hereditary pursuit in favour of cultivation, may also be a factor determining the decline of sericulture.

But the chief reason appears to be the abundance, the cheapness and the superiority of the imported raw silk.

Thus, the silk-weavers of the Province become more and more dependent upon foreign countries for their material in the raw.

III.—Import of Raw Material: Its Sources.

Until about thirty years ago, raw silk, as wound off the cocoons, was said to have been imported into Mandalay from China, *viâ* Bhamo. It was called *tayôk-po.* The purport of the name is obvious. It was also known as *Kinggyi-po* from the enormous size of the coils which sometimes measures as much as twelve feet in circumference! Gradually, the overland import from China gave place to imports from the Straits, and, possibly, the Malay States. It is still used, but in comparatively small quantities. Again, the imports from the Straits are being gradually ousted, of recent years, by a better quality of sea-borne raw silk from China. Previous to the introduction by China of her produce into the country, the Straits were the only market from which raw silk was brought by sea to Burma. In 1897-98 the total import trade from the Straits amounted to about sixteen lakhs.

Until 1890, Siam was the chief source of land-borne supply of raw silk, but since that year Western China has steadily usurped her position.

The following tables show the sea-borne and land-borne trade between Burma and the adjoining countries from 1890-91 to 1897-98.

TABLE II.—*Sea-borne Trade.*

Year.	From China.		From Straits Settlements.		Total.	
	lbs.	Rs.	lbs.	Rs.	lbs.	Rs.
1890–91 ..	..	..	372,059	24,40,434	342,059	24,40,434
1891–92 ..	..	..	319,745	20,30,859	319,745	20,30,859
1892–93 ..	..	..	356,783	22,31,946	356,783	22,31,946
1893–94 ..	..	..	348,888	21,81,651	348,888	21,81,651
1894–95 ..	..	..	151,278	7,78,650	151,278	7,78,650
1895–96 ..	1,094	6,564	388,147	21,58,630	389,241	21,65,394
1896–97 ..	3,005	16,795	311,266	16,69,840	314,271	16,86,635
1897–98 ..	19,081	87,048	361,641	15,44,138	380,722	16,31,186

TABLE III.—*Land-borne Trade.*

Article.	For Triennial Period ending 31st March.			For year ending 31st March.	
	1890.	1893.	1896.	1897.	1898.
	Rs.	Rs.	Rs.	Rs.	Rs.
Raw Silk	1,14,256 (Siam 67,546, China 27,000)	11,37,308 (Western China 9,53,100, Siam and Zimme part of balance)	19,53,395 (Western China 18,97,100, Siam and Zimme part of balance)	4,38,130 (Western China 4,15,875)	2,84,619 (Western China 2,68,125)

The import of raw silk from Siam has shown some tendency to revive since 1911-12.

The following table shows the sources of raw material, its import and estimated value during the last five years (1908-09 to 1912-13) :—

TABLE IV.

COUNTRY.	1908-09.		1909-10.		1910-11.		1911-12.		1912-13.	
	lbs.	Rs.	lbs.	Rs.	lbs.	Rs.	lbs.	Rs.	lbs.	Rs.
Straits Settlements.	167,288	9,71,104	103,078	5,32,321	117,588	5,89,795	135,119	6,43,136	96,930	4,67,676
Hongkong ..	44,702	3,15,058	31,856	1,90,840	81,121	4,44,743	100,975	6,51,603	118,703	8,29,951
Siam ..	..	..	..	..	..	..	8,645	14,580	23,730	85,310
Indo-China ..	..	..	..	..	..	..	100	903	..	..
China ..	264,583	15,77,010	204,269	9,98,928	60,083	3,18,916	158,190	9,13,777	302,458	17,16,602
Japan ..	2,806	6,698	5,489	28,776	13,040	64,852	..	..	7,927	44,650
TOTAL ..	479,279	28,73,773	344,687	17,50,872	271,832	14,18,306	393,089	22,57,089	549,750	31,44,189

This gives a net total of 2,038,637 lbs. of raw silk estimated at Rs. 1,14,44,229 imported into and worked in the country during the last half decade. The net import has increased in 1912-13, and it is noticeable that the imports from the Straits have largely fallen off, while those from Hongkong and China have taken an upward curve, and the trend of the curve bids fair to continue going up. This is probably attributable to the fact that the Chinese silks are more suitable for the country looms, take colour more satisfactorily in the process of dyeing and are easier to manipulate, on account of their "tenacity" and "elasticity," than the silks from the Straits and elsewhere. It is noticeable that though the import from Japan showed an increase for some years previous to 1911-12, that year the import was *nil*, and in 1912-13 only 7,927 lbs. estimated at Rs. 44,650 were imported. The reason may be due to the excessive fineness of the thread and its consequent unsuitability to the Burmese looms which require fairly tough materials. If this theory is correct, it would be interesting to watch the Japanese import of raw silk in this country for some years to come.

The figures in the foregoing table show a steady and marked increase. The total import in 1892-93 was 356,783 lbs., estimated at Rs. 22,31,946, while that in the year 1912-13 was 549,750 lbs., estimated at Rs. 31,44,189. In face of this fact it is rather difficult to endorse the opinion held by some that the weaving industry in Burma is in a decadent condition owing, as they assert, to the competition of foreign countries in the shape of the *finished* machine-made products.

IV.—Aspects of the Industry: Past and Present.

In 1901 there were 34,103 silk spinners and weavers. In the Census Report of 1911 the provincial total number of the same is given as 18,621. The latter figure includes 245 spinners and weavers in the specially administered territories, namely, the Northern and Southern Shan States. In Burma proper, therefore, the industry gives occupation to 18,376 persons, to some of whom being also agriculturists, the industry is an auxiliary one.

In this connection, the following extract from the last Census Report is interesting :—

"The majority of weavers and spinners are members of agricultural families, though in some localities the industry is sufficiently established to furnish full-time occupation for a comparatively large proportion of the population. The agricultural expansion of the past thirty years has tended to affect the textile industries adversely in two directions. On the one hand, the large extension of cultivation, simultaneously with advancing prices, has made the population as a whole much less dependent than formerly on the produce of such domestic industries. On the other hand, in order to balance the enormous and advancing exports of paddy from the Province, articles of European manufacture have been imported in immense quantities. Economic forces have been tending to stimulate the agricultural industries of the Province at the expense of those industries not directly connected with the disposal of agricultural produce. It is a commonplace among administrative officers of long standing that both the cotton and silk village industries are decaying. The sound of the loom which used to be heard continuously from morn till eve in almost every house in the village, is now hardly heard, either so continuously or so frequently as formerly. The figures (of the population supported by silk-weaving industries in 1901 and 1911) given probably over-estimate the decline. In addition to having been recorded under rather more definite and stringent conditions as to inclusion, they show the figures for that portion of the industry in which the decline has been most rapid, namely, that carried on for purposes of trade. Spinning and weaving for household use has not been affected so seriously by the competition of European piece-goods as spinning and weaving for a livelihood. The Census records show the decline where it is most apparent, and omits to present figures where the decline is of a far less serious character."

The falling-off in the number of spinners and weavers during the last ten years is no definite indication of a corresponding declining tendency of the industry in *Burma* ; for, this pessimistic theory, if adopted, could hardly be reconciled with the fact that the figures

show a marked increase in the import of raw silk into the country during the same period. The industry has changed its aspect for some time : and the period of this change may be called the period of the "Struggle for existence," during which time some appear to have been unable to maintain their ground, while those who have survived appear to have consumed a greater amount of raw material to meet the exigencies of the times than they used to do before the critical period referred to above. Besides, being a lucrative occupation, the silk industry had an interesting aspect during the Burmese régime. Costly silk fabrics of various handsome patterns were then manufactured for the members of the royal family and officials in addition to the ordinary stuff for the masses. Foreign silks were all but unknown : and, as the Court from the "Lord and Master of Land and Water, and Possessor of many White Elephants," down to the humble page, and from the redoubtable Queen Supayalat down to the lowliest officer's wife—as all the galaxy of rank and power, of youth and beauty,— scorned to wear anything but silk, the looms in and around Mandalay, and other manufacturing centres were certainly hardly ever idle. King Mindon got out two master-weavers in velvet and silk from France to turn out fabrics for himself and the royal family. The names of Messieurs Denegri and Canepa are cherished to this day by those of their old workmen and pupils who still survive. These gentlemen had to bring out their own looms and accessories, but had the misfortune to lose everything by shipwreck. Nothing daunted, they built their own looms and set to work for His Majesty. Their turn-out in velvet and silk was the admiration and the envy of the Burmese weavers. The daughters of these two gentlemen who died in Mandalay, are still in the silk business, continuing the best traditions of their fathers. Those interested in the promotion of the silk industry would find it advantageous to keep in touch with them, especially with Mons. Canepa's daughter who is turning out some of the finest fabrics to be had in Mandalay on an Italian loom which is her father's pattern. I had the pleasure of inspecting her loom and the lady was kind enough to give me some practical information on the subject.

Since the Burmese régime, there has been no demand for costly materials, and consequently most of those, if not all, who were engaged in manufacturing the costly articles, are supposed to have given up their work and taken to cultivation or other occupations. Besides, the taste of the people gradually changed, and new associations and cheap and gaudy foreign fabrics found their way into the country. Under these circumstances, some are supposed to have found it difficult to maintain their ground in the face of foreign competition. These causes appear to have worked in diminishing the number of weavers, but the decrease does not appear to have affected the industry. The expert weavers have been carrying on their work successfully and their numbers have been increasing in the main centres of the industry, as will be evident from the following statement :—

TABLE V.

District.	Number of weavers.	
	1891.	1911.
Mandalay	9,844	9,903
Tavoy	1,107	2,244
Henzada	538	640
Yamethin	51	100
TOTAL	11,540	12,887

Only in Prome have the numbers largely fallen off from 4,474 to 2,753. Those who have given up the industry at this place are supposed to have taken to agriculture.

There appears to be every prospect of the industry progressing provided the weavers are induced to adopt up-to-date methods and appliances. They know their art well, but have no means to buy, and are not equipped with the necessary knowledge to use the improved loom, which shows greater output and requires less amount of labour to manipulate than the old-fashioned apparatus. It is an acknowledged fact that the weavers, however expert they may be, cannot keep pace with the times unless they have neces-

sary facilities and the latest textile requisites at their command. Owing to these deficiencies the industry appears to be languishing or in a depressed condition: but there is still potential life in it to make it susceptible of a vigorous and healthy development.

V.—Amarapura.

Amarapura, the last of the royal cities of Burma before Mindon Min transferred his capital to Mandalay in 1856, now exists on its ruins and traditions, and on what survives of its once flourishing industries of the past. The inhabitants of a number of little villages (*vide* Table *infra*) are engaged to a considerable extent in the spinning and weaving of silk. These villages, the fossil-like survivals of the once great "City of the Immortals," are built of wood and bamboos, and are picturesquely situated in shady gardens on, and near, the left bank of the Irrawaddy river. The so-called town of Amarapura is the chief centre of the silk-weaving industry, not only of the Mandalay Division, but of the whole province of Burma. The total population engaged in the industry throughout the country is 18,376 in 1911, of which more than half, namely, 9,903, reside in the Mandalay Division, and of this number the great majority is to be found in and around Amarapura. The villages, in which the weavers predominate, are poorly built and some are situated on low-lying spots, subject to annual inundations of the Irrawaddy river. The weavers are by no means noted for their physical development, being of weakly constitution and sallow complexion owing, no doubt, to their sedentary habits and poor nourishment (fish and rice). But although weakly, they are by no means unhealthy as a class, even though they live in damp localities. The shade afforded by large tamarinds and other densely foliaged trees helps to prevent the evaporation of moisture from the soil, so that the weavers live and work in an atmosphere which is humid enough for all the purposes of successful manipulation of the silk fibre. The humidity maintains elasticity and suppleness which render the silk easy to handle and work. Whatever may have been the causes which have contributed to the establishment and survival of the industry in Amarapura, few sites

so well suited for the purpose could have been chosen in the plains of Upper Burma.

The fact that Amarapura is the chief centre of the weaving industry in the country is further proved by the quantity of raw material used annually in the Sub-division.

*Of the net import of 549,750 lbs. of raw silk imported during the year 1912-13, nearly 300.000 lbs. were, according to the Assist*ant Registrar of Co-operative Societies and Maung Po Thin, raw silk merchant, used by the weavers of Amarapura alone. Prome and Tavoy stand next to Amarapura in the order named. Tavoy fabrics, known as *Dawe-longyis*, are popular in the Province for their durability, and command better prices than Surati longyis imported from Surat, but the latter are more generally adopted in the country owing to their cheapness.

(*a*) *Centres of Manufacture.*--Twenty-eight villages carry on the weaving industry in the Amarapura sub-division. The following table shows the names of the villages, the number of houses in each village and the looms working in those villages :—

TABLE VI.

No.	Village.	No. of houses.	No. of looms.
1	Thinbangon	100	200
2	Taroktan		
3	Padein	250	600
4	Sadaiktan		
5	Kunthidan		
6	Peindan		
7	Shangaung		
8	Ka-théze		
9	Maungdan	300	1,000
10	Lezu		
11	Odaw	280	1,000
12	Taunggyi	160	450
13	Hintha	100	200
14	Pabédan	150	300
	Carried over	1,340	3,750

TABLE VI.—(*Cont'd.*)

No.	Village.		No. of houses.	No. of looms.
		Brought forward	1,340	3,750
15	Kyandan ..	..	150	100
16	Bôn-o			
17	At-kyok	..	100	300
18	Kôkko			
19	Pônnazu	..	250	300
20	Shwegé ..	..	600	1,500
21	Sangwe ..	..	650	1,000
22	Letpanzin ..	..	50	200
23	Shwekyetyet	..	300	300
24	Yegyibauk			
25	Leiksangun			
26	Sado	..	1,000 (approximately)	250
27	Myobyingyi			
28	Lebo			
		TOTAL	4.710	8,000

The above figures of the weaving looms are subject to fluctuation—rising and falling according to the demand for the fabrics. When the demand is great during the months of Tazaungmon, Nadaw, Pyatho, Tabodwe and Tabaung (December, January, February, March and April) more than 10.000 looms are busily at work. During the rest of the year the number varies according to the demand, but very seldom rises above 8.000.

(*b*) *The Country-Loom* (see text-figure p. 271).—The country loom (*yekkansin*), as we find in Amarapura consists of the following parts :—

(*a*) The frame-work.
(*b*) The warp-beam.
(*c*) The cloth-beam.
(*d*) The heddles.
(*e*) The reed.
(*f*) The shuttle.
(*g*) The treadles.

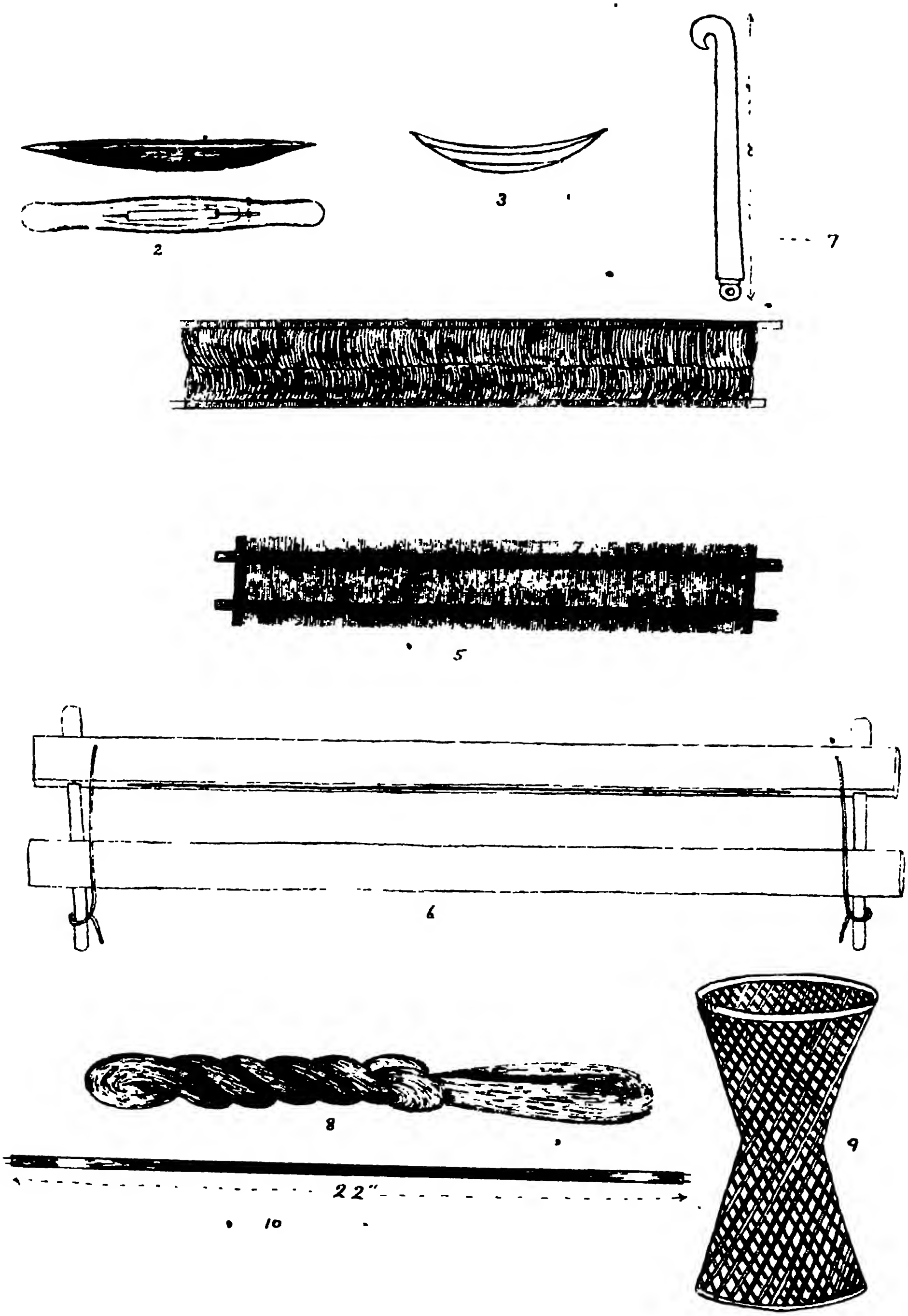
The frame-work is made up of four solid posts, about three inches square, which are held rigidly in position by transverse beams.

There are a pair of latitudinal cross-beams, one on top and the *other a few inches from the ground. The longitudinal cross-beams are three pairs in number. One on the top, the second, the most* important, a few inches below the middle of the frame (the height of a writing table), and the third about six inches below it and eighteen inches from the ground. The second beam is the most important, as the chief working parts of the loom, the cloth and warp poles, are manipulated thereon.

The warp-beam is a round cross-beam fixed at one end of the frame-work behind two of the posts on projections of the middle longitudinal beams, and held in place by being inserted into two wooden notches fixed behind the two perpendicular posts. It is around this beam that the warp is wound in parallel even lines. Opposite to this warp-beam and on the same longitudinal beam is fixed the cloth-beam on which the finished portion of woven cloth is wound. Unlike the warp-beam, the cloth-beam is about eighteen inches away from the posts, so that the operator, whose seat is placed between the lowest longitudinal beams and touching the posts, works practically within the frame of the loom. Both the warp-beam and cloth-beam are known as *leik* in Burmese.

In front of the operator come the heddles (*hnat*)—and the reed (*yathwa*) through which the threads of the warp are passed (Pl. XXI, Figs. 4 & 5). In ordinary plain weaving there are two heddles consisting of twines stretched between two rods or pieces of board and looped in the middle through which each thread of the warp is passed. The first thread of the warp passes through the first loop of the first heddle and the second thread of the warp through the first loop of the other heddle; and thus alternately all the threads pass through the two heddles and are separated into upper and lower rows, so as to allow of the shuttles being passed between them. The heddles are hung on pulleys (*set-thi*), so that, when the treadle (*che-nin*, ordinarily of bamboo) to which each is attached is depressed by the foot of the weaver, it also depresses the number of threads passing through its loops, and raises the other heddle with the threads passing through it. Thus, by raising and lowering the heddles, the weaver is enabled

PLATE XXI.



Figs.-1. & 2. Shuttle used in Amrapura (side and top view.)
3. Shuttle described by Hardiman. 4. Heddle. 5. Reed. 6. Battens.
7. Kawsi. 8. Meik pha silk showing a dangling [illegible]

to open out the warp in front of him and throw the weft back and forth through the opening.

The reed is an oblong narrow frame of bamboo filled with fine teeth made of the strips of yon (a small tree with hard wood—*Anogeissus acuminata*). These strips are placed in fine comb-like order more or less closely together according to the fineness of the fabric to be woven. This kind of reed is preferred by the weavers to the steel or brass reed. It is enclosed and held in position by a wooden frame-work called the "lay" or batten (*let-khat*) [Plate XXI, Fig. 6]. It swings on strings attached to a bamboo supported by the top longitudinal beams. The weaver, after throwing the weft, pulls the reed by the battens towards himself more or less forcibly in order to comb and beat up the threads.

The shuttle (*lun*) described by Mr. Hardiman is a small wooden trough in the form of a skiff. It is made of hard black wood, yindaik (*Dalbergia cultrata*) or, if large and for white fabrics and fabrics of simple patterns, of the almost equally hard wood, padauk (*Pterocarpus macrocarpus*). Both its ends are tapering and long, while the centre contains the trough into which the bobbin or spool with the weft yarn is placed and one end of which is passed through an eye on the side of the trough (Plate XXI, Fig. 3). The shuttle, commonly used in Amarapura, is oblong, constricted near the rounded ends and bevelled along the upper edges. It is ordinarily about 8½ inches in length with a slot in the middle to accommodate a three-inch spool (Plate XXI, Figs. 1, 2). As the heddles are raised up and down, the shuttle is thrown by one hand of the weaver, and caught by the other hand at the other side of the warp.

A country loom with all appurtenances and fixtures complete costs between Rs. 20 and Rs. 30.

(*c*) *Process of Manufacture—Legend.*—The mechanism and methods being primitive in the extreme, it is not surprising that the processes of manufacture are numerous, intricate and laborious. There is a legend to the effect that a girl who was being initiated in the mysteries of the art, drowned herself in sheer despair and disgust and became a fish known as *labhaing* (porpoise). Hence, the Burmese have a curious belief that all *labhaing* fish are

females and that these mate with a bird called *hnget-kye* (of the crane family). Burmese fishermen consider it unlucky to molest this fish.

Processes.—The weaver generally buys his yarn ready spun, warps it and sizes it himself with the help of the other members of his family or hired people. He adopts the following process successively for the manufacture of his fabric :—

SORTING RAW SILK.
(Po-kwe-gyin.)

1. *Po-kwe-gyin*—(Sorting).—This process consists in the sorting of the filaments of the skein (*akwet*) of raw silk in order to prevent them from being entangled.

2. *Po-pyok-gyin* (Boiling).—After sorting, the raw silk is boiled with sand soap in an iron cauldron or earthen pot over a furnace. When the water reaches the bubbling point, the skein is held by the hoop of a bent iron bar or cane (*gauk*) which serves as a handle. The skeins are plunged into the water and are kept there till they become coarse to the touch. They are then taken away from the pot and the water is squeezed out by holding the *gauk* with one hand, and with the other hand forcing a piece of stick into the opposite end of the skein.

3. *Po-shaw-gyin* —(Washing). When it gets cooled, the boiled silk is washed four times in cold water to bleach it. The water is wrung out and the silk is dried for a day. White silk becomes pure white and yellow silk pale yellow. The cleaning process is also known as *po-kyut-gyin*

4. *Po-so-gyin*— (Dyeing).—The bleached silk is then dyed into required colours. The imported aniline dyes (mostly German) have now taken the place of the vegetable dyes, such as, *saffron* bulbs, indigo leaves, ripe plum (*zi-thi*), safflower, cutch, etc., which were formerly made use of, the former being less troublesome and less expensive than the latter. Lac was originally used for obtaining the deeper red colours. The aniline dyes, now used, are chiefly supplied by three great German firms—Badische Aniline and Soda Fabric, Farben fabriken Fr. Bayer and Company, and Farbwerk Vorm Meister, Lucius and Bruning—through their agents—Messrs. Bulloch Bros. and Company, Ltd., Messrs. Galliara Bros, and Messrs. J. L. Backofen and Company, respectively. In certain cases where the aniline dye is not allowable, the vegetable dye is still used. For example, the raw silk which is used for the manufacture of orange-coloured fabric for the Burmese Buddhist monks (*pongyis*), is dyed in a solution prepared by steeping the seeds of a tree known as *thidin bin* (*Bixa Orellana*) in water. The seeds are covered with a deep orange-coloured powder and when they are rubbed in water mixed with sand soap, the water assumes the orange colour. The jack tree (*Artocarpus integrifolia*) also supplies the material for dyeing this cloth. It is interesting to note the fact that it is irreligious for a *pongyi* to wear a garment dyed with a **bark** of *dauk-yat* tree, but

it is open for him to wear one dyed with the leaf of this tree or the leaf of any tree or plant except the leaves of *Me* (*Indigofera tinctoria*) and the *dan* (*Lawsonia alba* or *Lawsonia inermis*). Priests may use any bark for dyeing their garments except that of the *dauk-yat* and the *kya paing* trees.

5. *Po-ka-gyin*—(Drying the skein by giving sudden smart pulls).—A bar of bamboo or wood is supported horizontally on two vertical posts, the top ends of which have holes for supporting the bar. One end of the bar is taken out of the hole, inserted through the washed or dyed skein, and replaced in the holes. A piece of stick about two feet long is then also inserted into the skein by means of which the latter is jerked smartly and the water wrung out. The filaments of the skein are freed by this process and dry rapidly.

The dyed silk, which is intended for the warp, is rubbed with rice-glue, dried in the sun and then combed.

6. *Po-cha-gyin*—(Reeling).—The next process is to put the combed silk over a swift (a machine from which thread is wound—Burmese *cha*) and to transfer the threads on to the reels (*yauklon*). The threads of different colours required for the manufacture of the fabric are wound on these reels.

7. *Cha-pôk-gyin*—(Preparing warp).—The reels are then arranged vertically on a bobbin-frame (*yauk-lôn-gôn*) and several threads are at a time transferred on to a bigger swift. These are then kept in separate coils according to their colours, and the lengths required, for four, five or six *pasos* (waist-cloths worn by men), as the case may be.

8. *Yathwa-kaw-gyin*—(Threading the reed).—Next, the looped ends of the threads of the warp are drawn out through the reed by means of a special hook called *Kaw-si* (Plate XXI, Fig. 7).

9. *Yet-kan-leik-chin*—(Beaming-on).—After threading the reed, the warp-threads are wound on a roller (*leik*) which is fixed into two upright posts and turned round by means of levers (*see* Plate XXIII).

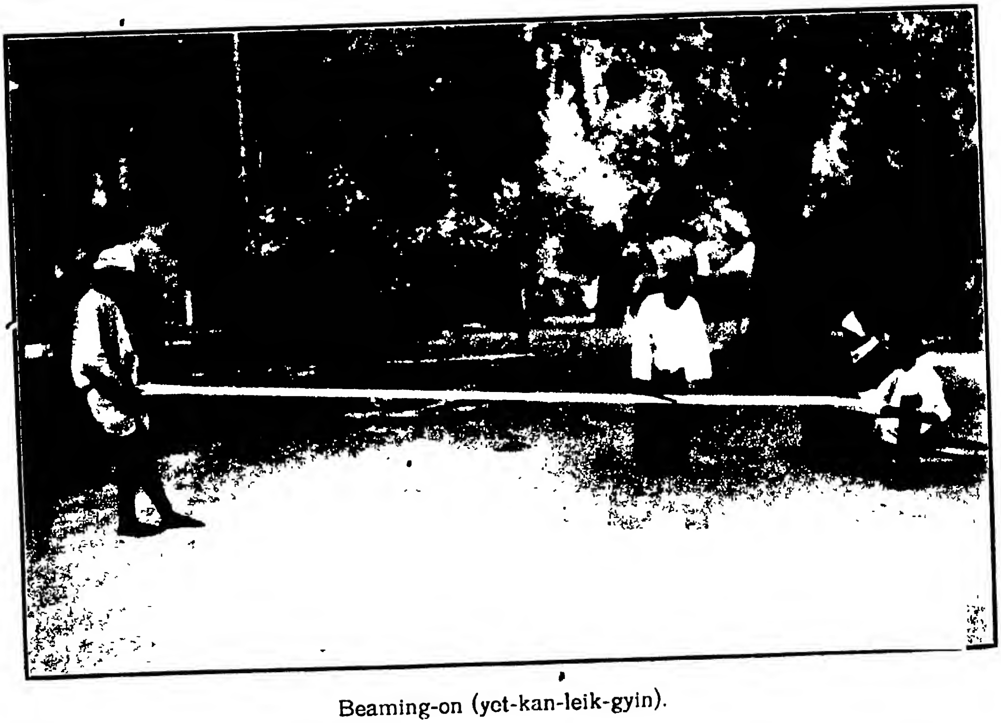
b a

Reeling (po-cha-gyin) a. swift. b. reel

b a

Preparing warp (cha-pok-gyin)
a. Bobbin-frame (yauk-lon-gon), b, large swift.

Threading the reed (yathwa-kaw-gyin).

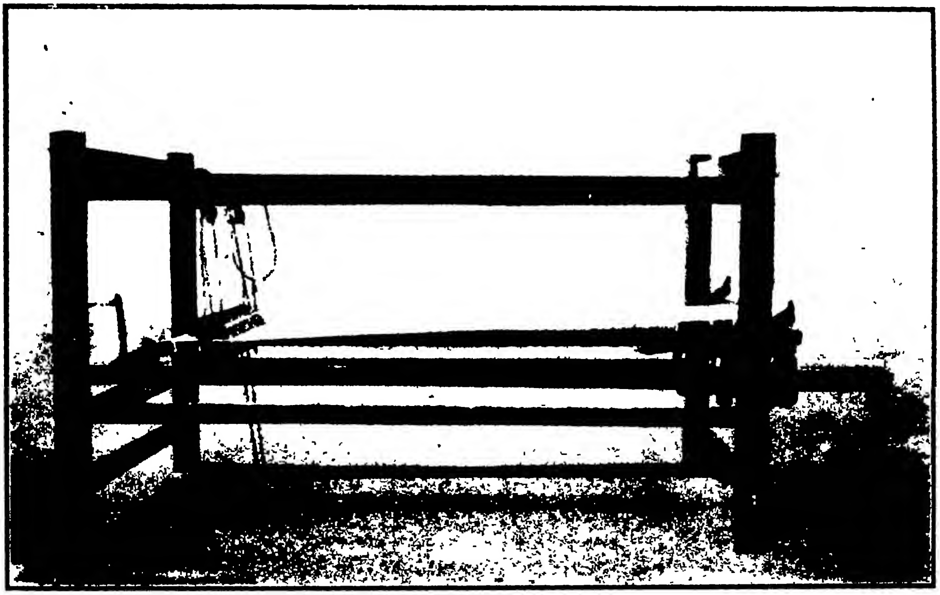


Beaming-on (yet-kan-leik-gyin).

10. (*Hnat-kauk-gyin*)—(Threading the heddles).—Each thread of the warp is then made to pass through two pairs of heddles of strong cotton threads.

11. *Yet-pauk-yauk-gyin*—(Winding weft on to spools).—Next comes the 'filling' of the spools which supply threads for the weft. The spools are placed in the troughs or slots of shuttles (*see* Plate XXIV).

12. *Yet-kan-yet-gyin*- (Weaving).—Lastly, we come to the final process—weaving, which consists, as is ordinarily the case, of four movements, namely, (*a*) the 'shedding' or the process of opening the alternate layers of the warp: (*b*) the 'picking' or projecting the shuttle with one hand and catching it with the other or shoot-



COUNTRY LOOM (SUPERIOR KIND).
(Yekkan-Sin).

ing the weft, as it is commonly called: (*c*) the 'combing' or 'battening' or pulling the batten with the left hand, using such force as the closeness of the texture requires or beating up the web; and lastly (*d*) the winding of the woven portion of the cloth. When a certain length of cloth has been woven, this portion is wound on

the cloth-beam while at the same time an equal portion of the warp is unwound from the warp-beam. The proper tension is maintained either by weights suspended by chords from the warp-beam, or preferably, by a system of leverage working between the cloth and warp-beams by means of a taut rope, the ends of which are fastened to the levers or pins inserted into the holes, one on each left hand-end of the two beams. The cloth, when woven, is kept from contracting in breadth through the shrinking of the warp by means of a piece of flat hard wood, the extremities of which are armed with sharp metal points which pierce the 'selvage' of the cloth and thus keep it distended. They are called 'temples.' (Plate XXI, Fig. 10).

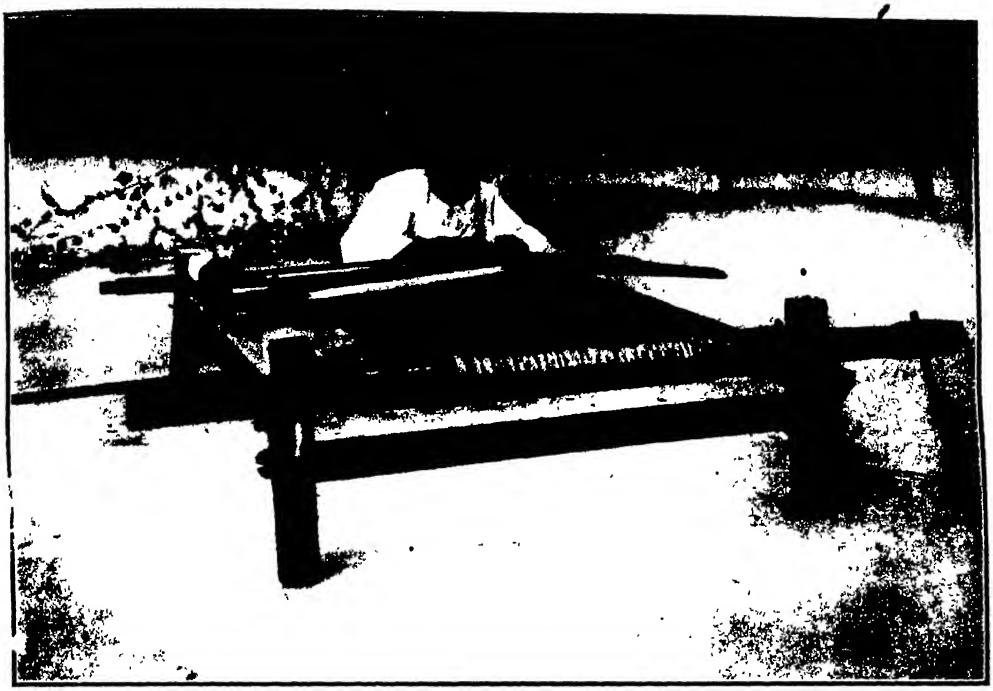
VI.—Classes of Raw Silk Imported for Manufacture.

Silk in its raw state is known as *Po-yine* (Burmese *yine*-coarse, wild). It arrives in a twisted as well as in an untwisted state. The untwisted silk undergoes the twisting process in Mandalay on a local twisting machine (Plate XXV).

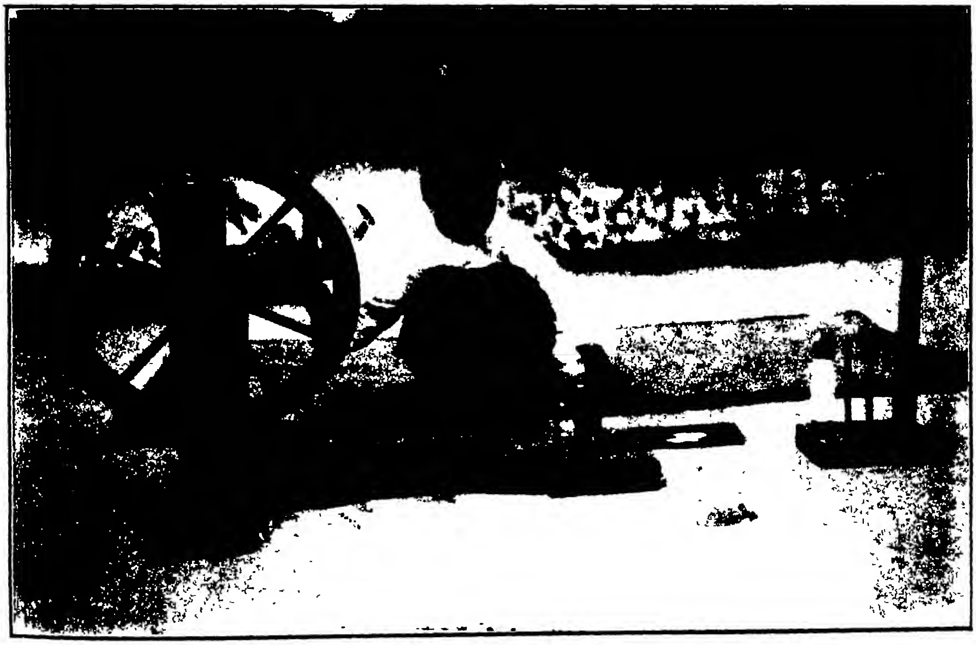
A considerable number of names are given to various classes of raw silk, which are imported into the country. Some of these names refer merely to the source from which the silk is imported, some refer to the mode of knotting the skeins, some again to quality and adaptability for use in the various processes of weaving. These various grades of raw silk are difficult to classify. Most of them have ceased to be in demand and only the following are now used in the country.

1. *Meik-pha-po* (*meik* from *ameik* the dangling end : *pha* to hang loosely about : *po* silk : silk with a tassel-like dangling end) (Plate XXI, Fig. 8). The derivation of its name is due to the fact that the skein of this silk is not coiled, or roped, in two strands from end to end. One end, about a foot in length, is kept loose in a single strand, being separated from the coil by a knot. The name is applied to Meinyang yellow silk imported from Shanghai, which arrives in an untwisted state. It is simply re-reeled (not twisted) and used only for the weft in Amarapura. But in the Lower Chindwin, Pakokku and other districts, it is twisted on a local twisting

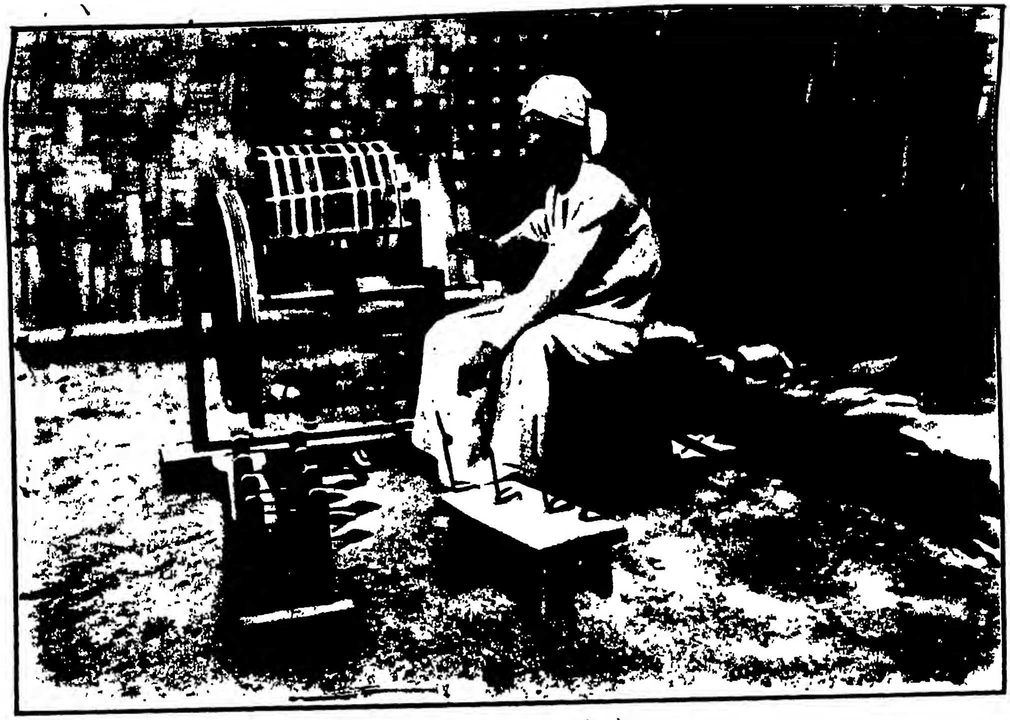
PLATE XXIV.



Threading the heddles (Hnat-kauk-gyin).



"Filling" spools (winding weft on to spools) (yet-pauk-yauk-gyin).



Twisting Machine (yit).

Madras Fly-shuttle loom.

machine (*yit*) before it is used for the weft. The price of this silk ranges between Rs. 19 and Rs. 27-8 per *viss* (3·6 lbs).

2. *Gwin-do-po.*—The name applied to Fanchow silk imported from Shanghai. It is also used exclusively for the weft and its price varies from Rs. 22 to Rs. 25. A comparatively small quantity of this kind of silk is imported, *meik-pha-po* being superior to it.

3. *Quanton-po.*—The name given to the white silk imported from Canton.

4. *Shang-tung-po.*—The name applied to the yellow silk imported from Shan-tung in China.

Numbers 3 and 4 are imported in a twisted state and they sell for from Rs. 25 to Rs. 35 per *viss*. They are used only for the warp.

5. *Tayok-po* literally means China silk (*Tayok* China, *Po* silk). The name is applied to the silk imported from Yunan. It is also called *Kin-gyi-po* from the enormous size of its coils, which, as stated above, sometimes measure as much as twelve feet in circumference. It is brought over on pack mules. It arrives in a twisted as well as in an untwisted state, the proportion being one-third : two-thirds. The price varies from Rs. 15 to Rs. 20 per *viss* according to quality. The lowest grade of this silk is sent to the Southern Shan States where it is used in the manufacture of coarse material for local consumption.

6. *Thabeik-chi-po* (*Thabeik*—bowl of a Buddhist monk, *Chi*—foot). It derives its name, according to Maung Po Thin, silk merchant, from the peculiar knotting of the skein, a shape fancifully compared to the fixed socle of a monk's alms-bowl. (Plate XXI, Fig. 9).

Another version of the origin of the name is equally curious, but less popular. This silk would appear to be used in making the net-worked bags which some *pongyis* use in carrying their bowls slung from the neck (the word *chi* means 'to carry' as well as 'foot'). It is imported from Tong King and is used both for the warp and for the weft. Its price varies from Rs. 19 to Rs. 25 per *viss*.

lengths stitched together lengthwise make one *paso*. Unlike the *bala paso*, it is woven in a single piece. The greatest length for a woman's *longyi* is five cubits and for the *tamein* is three cubits by twenty-seven inches.

The *acheik* has many fancy patterns (Plate XXVI) and its price is according to the design. The highest priced *acheik* for an adult was worth Rs. 250—300 under the old régime. Only the kings and princes, ministers (*won*) and tributary chieftains (*Sawbwa*) could afford to buy it. Karens and Talaings are said to be very fond of it. The present price of a *paso* ranges between Rs. 50 and Rs. 100, that of a *longyi* between Rs. 25 and Rs. 40, and that of a *tamein* between Rs. 9 and Rs. 16. Pure Burmans have relinquished the fashion and it is hardly woven now.

The Bodaw-gyo.—The name applied to a fabric having broad, wavy lines for its pattern. It is said to be named after King Bodaw Paya who is supposed to have set the fashion of that *acheik*. It cost Rs. 150 during the Burmese régime. It is out of fashion now.

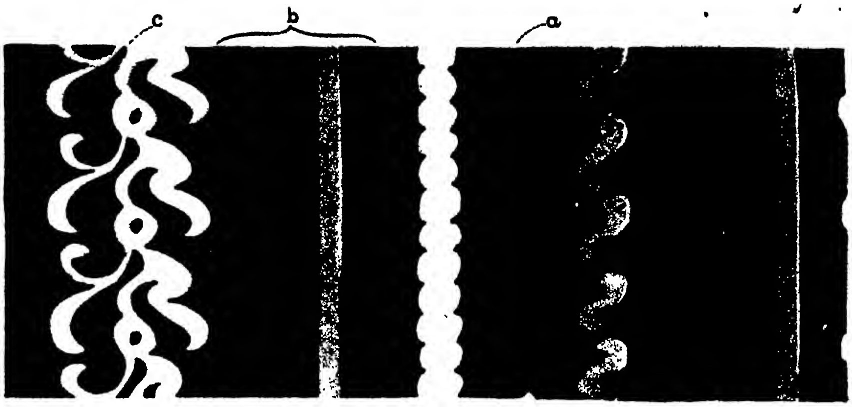
(2) The *Sat* (to join, unite, blend colours). The name is applied to a fabric which shows principally straight linear patterns of different colours (Plate XIX, Fig. 6). Like *acheik*, it is also worked with a number of small shuttles, the number varying according to the different colours used in weaving the fabric. It has almost gone out of fashion : its use is said to be confined to old-fashioned people.

If a simple *acheik* pattern of the *gamon* flower *Kæmpferia rotundua*) is introduced here and there at intervals into the fabric, it is known as *satgamon*.

(3) The *gaik* or *kaik* (to take hold of as colours on cloth). The name was applied to a fabric which had peculiar designs, some of which are shown in Plate XIX, Figs. 7, 8. Gradually the pure *gaik* designs got out of fashion and were introduced in the *acheik* as well as the *sat*. Its price ranged between Rs. 25 and Rs. 40.

In the case of ordinary plain weaving with two or more heddles, the alternate layers of the warp are opened as the heddles are raised

PLATE XXVI.



Fig

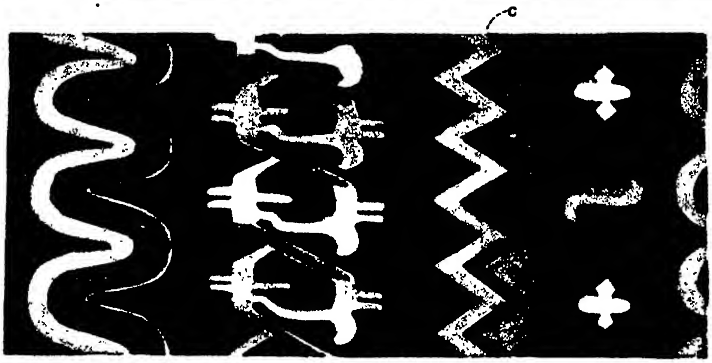


Fig 2

Fig. 3

Figs. 1. 2. 3. Mixed Acheik Patterns.
a. Pure acheik design: b. Pure sat design: c. Pure gaik design.

up and down and the shuttle is shot by one hand of the weaver, and caught by the other hand at the other side of the warp. But in the productions of the above three fabrics, the shuttles which are used are very small and they are made to pass above and below each successive thread of the warp; thus, the process is, therefore, more difficult and laborious.

(4) The *bala*, meaning blank, signifies that the fabric is plain. But even striped and chequered fabrics, which are turned out with two heddles go by the name of *bala*. Hence the *bala* may be plain or striped or chequered.

Thingan is a form of the plain *bala* and its colour is usually yellow or orange. Literally, it means a garment of a Buddhist monk. The usual length of a *thingan* is twenty-five cubits and breadth twenty or twenty-two inches. It costs from Rs. 18 to Rs. 24. Bishop Bigandet, in his life of Gaudama, says:—

"The *Thingan* (garment), or *Tsiwaran* is composed of three parts—the *thinbaing*, resembling an ample petticoat, bound up to the waist with a leathern girdle and falling down to the heels: the *kowut*, which consists of a sort of cloak of a rectangular shape, covering the shoulders and breast and reaching below the knee, and *dugôt* which is a piece of cloth of the same shape, folded many times, thrown over the left shoulder when going abroad, and used to sit upon when no proper seat has been prepared. In order to maintain a spirit of perfect poverty among the members of the order of recluses, the Wini prescribes that *tsiwaran* ought to be made up with rags picked up here and there and sewed together: the rule in this respect, at least, as far as its spirit goes, is thoroughly disregarded and has become almost a dead letter."

If the *bala* fabric is striped (*asin*) or chequered (*akwet*), it is named after the colours of the stripes or checks. As, for example, if the stripes and the check designs are pink, the fabrics are known as *pannu-zin* (literally, *pannu*—pink, *asin*—stripe) and *pannu-gwet* (literally, *pannu*—pink, *akwet*—checks) respectively. (Plate XIX, Figs. 2, 3 and 5).

If the design resembles a peculiar mat-work known as *kyudayan*, the fabric goes after that name. Note Kyudayan (*Kyu*—a

species of reed. thayan. pronounced with *kyu* as *dayan*—a mat) is made of the *kyu* reed (*Phragmites Karka*).

The bala paso may be seventeen cubits by twenty inches, or eighteen cubits by twenty-two inches. The piece is doubled on its length and stitched to make one paso. Its price varies from Rs. 11-8 to Rs. 16. Out of one *viss* of raw silk, four *pasos* or eight *longyis* or three *thingans* may be made.

The *Kaung-gin-sat* (literally, blended sky, *i.e.*, blended colours of the sky) signifies a fabric which has its colours blended like those of the sky in its various moods. Among the patterns that are found in this fabric, the striped or chequered designs are most common (Plate XIX, Fig. 1). It is a recently introduced fabric. Unlike in the *bala*, four or eight heddles are used for the production of this fabric. It resembles a twill and is called four or eight heddle-twill according to the number of heddles used in producing it. It is steadily coming into fashion and sells for from Rs. 35 to Rs. 45. With the use of more than a pair of heddles the alternation of colours on the same fabric is effected. Thus a check or a stripe may be pink on one side and white on the corresponding check or stripe of the reverse side.

A fabric of broad alternate pink and purple pink stripes, which has been turned out after Mr. Saunder's design on a fly-shuttle machine introduced by him at Amarapura, is said to have been named after this gentleman and known as *Saunda-Sat* (Plate XIX, Fig. 4).

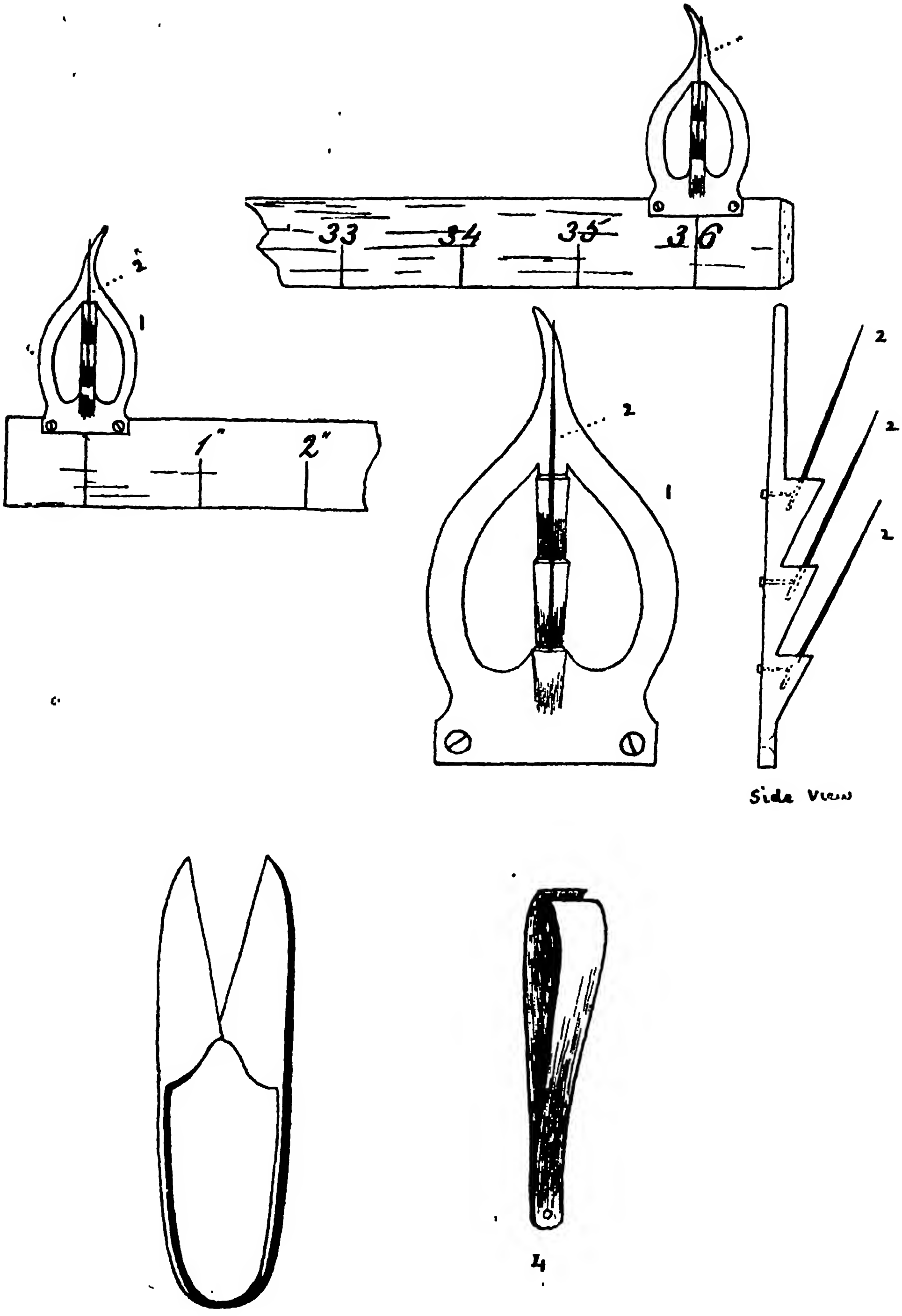
To the above four main classes of the native woven fabrics, the one known as *po-phyin* or *ingyi-phyin* may safely be added. The former are used only for waist-cloths, while the latter is used for jackets (*ingyi*) only. This stuff is woven in lengths varying from 40 to 100 yards and in breadths from 20 to 22 inches and sells for from Re. 1-8 to Rs. 2-4 per yard. It has found favour with Europeans who use it for their suitings.

Though the silk manufactured in Burma is noted for its durability, yet considerable improvement could be effected by introducing what is known as the 'twisting' process of the thread.

The method now in vogue gives the thread used for the warp only a single twist, while the thread for the weft is not so treated. Silks, in the weaving of which twisted threads are used, are locally known as *akyit-po*, while the plain-threaded silks are known as *apwa*. Cotton silk, known as *po-chi* is also largely turned out, the proportion of cotton to silk being ¼ : ¾.

If properly treated after manufacture, the Burmese fabric compares not unfavourably in gloss and smoothness with the very best that France and Japan can turn out. Vendors in the local bazaars are, however, ignorant of the process or find the method too irksome to adopt. It certainly needs patience and time to carry out. This finishing process is practised by Mdlle. Denegri, whose establishment I visited with much interest and profitable instruction, and as a consequence she receives a very large share of European patronage.

When a piece (125 yards) comes from the loom, it is safe to say that it is anything but clean, for the weavers are not noted for their personal cleanliness and their surroundings are no better. Knots, irregularities and cut-threads are removed with the aid of special shears and nippers (Figs. 3, 4 below) indented from France. The nippers are used to draw out the knot or stray strand with the left hand, while with the right hand the operator cuts it off. Next, the silk, no matter of what colour, for the dyes are fast, is vigorously sponged all over with cold water. The sponge is squeezed out in a basin and the colour of the water after a few applications of the sponge is decidedly dirty. This means so much dirt removed from the silk, as well as rice-glue that had been used during the process of warping. Stains and oil spots are removed with soap: and if necessary, benzene is used. Then the silk is ironed and takes on a remarkable sheen and polish. The folding is ingeniously done. The silk is distended by one 'selvage' on two pins exactly a yard apart. Three sets of pins are screwed on to two brass clamps (Figs. 1, 2 below). As many as one hundred and fifty yards at a time (fifty yards to each pair of pins) may thus be folded neatly and with precision in less than three minutes.



FIGS. 1. BRASS CLAMPS. 2. PINS. 3. SHEARS. 4. NIPPERS.

VIII.—THE OUTLOOK.

"The Burman," says Mr. Hardiman, "has an admiration for enticing patterns and for colours which are beyond his own creation, and is quite willing to sacrifice durability for cheapness and variety. He finds it easy to earn a livelihood, and motives of thrift rarely appeal to him. He is fond of sight-seeing, and he enjoys the sight-seeing all the more keenly if his clothes are new and their colours brilliant. There is nothing he likes so much as new clothes, and fresh designs and colours. He has an Aristidean disgust for a head-dress which lasts from one generation to another. Hence it is quite natural, as it is certainly indisputable, that the showier and cheaper imported dress fabrics are driving out and will soon entirely supersede the Burmese product.

"It does not follow that the industry must come to an end. The qualities of durability and handsomeness which are tiresome to the Burman would, no doubt, if they were known, commend themselves to a considerable class of consumers in other countries. The handloom of Burma might then survive: it is a distressing reflection that, otherwise, an industry which is intimately associated with the national life of a picturesque people should be doomed to a more or less rapid extinction.

"Burma itself is not one of the quarters in which a market for Burmese silk can be anticipated. There is little prospect of increasing the industry and supplying local wants so long as the well-to-do classes continue to wear the cheaper machine-made fabrics of Japanese or English manufacture unless the cost of producing the native fabric can be diminished."

Who, knowing the Burman's idiosyncrasies, will not endorse Mr. Hardiman's statements? The Burmans are, no doubt, fond of enticing patterns and willing to sacrifice durability for cheapness and variety: and consequently the import of cheap foreign fabrics is rapidly increasing every year. The following figures show to what extent the import trade has progressed during the last three years.

TABLE VII.—*The Import Trade of Silk Piece-Goods.*

Foreign Country.	QUANTITY IN YARDS.			VALUE IN RUPEES.		
	1910–11.	*1911–12.*	*1912–13.*	*1910–11.*	*1911–12.*	*1912–13.*
United States ..	*25,900*	*65,860*	*43,100*	*27,627*	*47,424*	*34,966*
Ceylon	..	..	438	..	..	389
Straits Settlements ..	54,969	32,785	36,228	58,264	42,356	43,078
Hongkong.. ..	37,469	59,660	100,040	48,533	76,743	1,13,350
Germany	4,692	702	..	3,561	705	..
Belgium	4,111	4,771	..	3,108	3,864	..
France	3,566	2,073	6,730	4,084	2,032	7,971
Switzerland ..	1,454	..	4,307	2,272	..	7,833
Siam	441	..	713	686	..	700
Austria-Hungary ..	..	1,551	..	..	1,471	..
China (exclusive of Hongkong)	12,853	14,218	10,588	15,726	25,113	11,989
Japan	8,151,482	9,716,526	11,345,421	42,33,262	50,41,131	61,86,412
TOTAL ..	8,296,937	9,898,146	11,547,567	43,97,123	52,41,039	64,10,688

(*Note.*—The figures showing the imports of Indian and foreign silks from India are not shown.)

These increasing figures in favour of the import trade of foreign fabrics do not, however, in my opinion, leave any ground for pessimism. The fear that an industry "which is intimately associated with the national life of a picturesque people should be doomed to a more or less rapid extinction" is purely sentimental, and hardly justifiable if we look at the situation impartially. Facts and figures prove that, although some people prefer the "showier and cheaper imported dress fabrics," the demand for the locally manufactured fabrics is on the increase, and that the number of weavers is not sufficiently large to meet local wants. Moreover, the weavers are conservative in the extreme. They seem to prefer their old-fashioned appliances and methods to the advantages of improved looms and up-to-date processes, with the result that the output is small and insufficient to meet local requirements. This being so, there can be no danger of a glut in the market of locally manufactured stuffs. There are still many who prefer, or who, as the result of sad experience with the gaudy but flimsy foreign fabrics, have wisely reverted to the durable dress fabrics "made

in Burma. This is a healthy sign, and distinctly encouraging to those who watch the prospects of the silk industry in Burma.

If less gaudy than foreign makes, Burmese manufactured fabrics have the undoubted advantage of being more durable. But durability of the stuff means longevity of the clothing. According to Mr. Hardiman, the Burman regards sameness in his wearing apparel with an Aristidian eye of disgust. He is said to object not to the fashion in the cut or arrangement of his clothes, for these hardly change, but to monotonousness in these patterns and colour-schemes. Hence he says: "It is quite natural, as it is certainly indisputable, that the showier and cheaper imported dress fabrics are driving out and will soon entirely supersede the Burmese product." ("Silk in Burma." page 23.)

The writer of the above lines has perhaps forgotten the existence of the *pan-so* industry (re-dyeing of old silk) which is to-day in a thriving condition: or, perhaps, the business was not so widely carried on then (1901).

At the *pan-so* establishments, faded silk garments, such as men's head-dresses (*gaung-baung*), women's handkerchiefs (*pawa*), skirts, jackets, etc., are cleaned, re-dyed and given a marvellously glossy sheen. Line-patterns, vignettes, flowers are stamped with fast colours, if desired, on *gaung-baung* and *pawa*. Thus treated, the garments look almost as good as new, even to the fastidious and their freshness and sheen last for months. The prices charged are moderate. In Mandalay town, the writer has visited, at random, several such establishments and found that they were well patronized.

The reason, why foreign manufactured silks are more showy and less durable, is not far to seek. The manufacture of silk, like that of many articles of export, has not escaped the application to it of what is known as the more or less honourable 'tricks of the trade.' The threads in the raw are subjected to a distending process, almost to the snapping point. This increases the length of the silk at the expense of thickness and durability. Base and heavy dyes are also applied to increase the weight of the silk. The showy meretricious sheen is effected by the use of glues. These dyes and

glues come off on the first application of water, with dire result to the appearance of the once showy stuffs.

Our Burmese manufacturers are fortunately less sophisticated commercially than their foreign colleagues, and it is to their ignorance of the above described, doubtful, if lucrative, practices that we may ascribe the reason of the durability and longevity of their manufactures.

But, as has been explained above, the limited number of weavers with their primitive looms and methods, will hardly be able to cope with the local demand. The following may safely be set down as the desiderata which will tend towards the improvement of the situation, and the serious development of the silk industry in this country :—

(1) The weavers should be taught to realise the advantages of the improved looms.

(2) They should be taught how to manipulate them.

(3) They must have the advantage of preliminary expert advice.

(4) They should be taught how to prepare the best raw silk, and the art of dyeing.

The weavers of Amarapura have the reputation of being the best professional weavers in the country, and their work abundantly justifies that reputation. They know the tastes of their countrymen better than foreigners. They have the rare adaptability of imitating any foreign designs. If the demand is for showy and gaudy patterns and colours, they can very well supply their demand by the gift of imitation with the additional advantage of the durability of the fabric which is lacking in the machine-made materials of Japanese and European manufacture. But they are working under great disadvantages. Their condition is pitiable in many cases. Most of them are entirely at the mercy of the traders and capitalists who sell the raw material at credit prices and then demand the finished articles at low fixed rates. An average weaver takes six days to weave a *paso*, seventeen cubits long and twenty-two inches wide, if he works at the rate of ten hours a day. If he works on the hire-system, he gets Rs. 2 as his wages

for six days, that is, he gets only five annas and four pies a day, which is less than even the wages of a cooly. Under these circumstances, those who cannot maintain themselves and their families by engaging in this old industry, have often no other resource than to take up cultivation or cooly-work. The majority being, however, unfit for any hard physical work owing to their sedentary habits, have stuck to their profession. But the number of weavers is said to have increased during the last two years with the increase in the price of the *longyi* and the *paso*. This favourable change in the price of the local fabric is said to have slightly improved the situation in some places. Some weavers have become independent of, and some less dependent upon, the traders and capitalists under whom they worked on meagre wages.

IX.—The Co-operative Credit Society.

Amarapura is said to have set a shining example, and holds out the hope of a bright future for the industry. In this Sub-Division about eight weavers' Co-operative Societies have already been formed under the auspices of the Co-operative Credit Society and under the able guidance of its officers. These societies have, with the kindly help of Mr. Saunders, Officiating Judicial Commissioner, Upper Burma, introduced the fly-shuttle and other accessories, and established a small school, at which two weavers, who have learnt the use of them, are instructing their fellow members. The improved loom is the well-known Madras fly-shuttle loom (Plate XXV) which the Burmans call *kyo-swe-let-khat*. The new idea has been given a hearty welcome: the people are beginning to be convinced of the success which the new loom will undoubtedly ensure.

A weaver takes, as stated above, six days to weave a *paso*, seventeen cubits long and twenty-two inches wide, on a country loom, while he takes only two days to finish it on the new machine. Besides, a piece of only twenty-two inches in breadth is woven on the indigenous loom, while on the introduced loom a piece of forty-four inches can be woven during the same time. Thus, the latter saves time and labour which also means a saving

of money, and shows a greater output. On the old loom only two heddles are used, while on the new one as many as sixteen heddles may be used and more variegated patterns can be produced.

The eight societies are said to have adopted the programme *of sending one man each for training to the school; thus a batch of eight men will be trained yearly.* The eight men who have already been trained, were offered a monthly salary of Rs. 15 for their services, but they declined and showed willingness to work on their own responsibility, if the Societies could help them with necessary funds to buy raw material and new looms. A sum of Rs. 200 will, it is said, be advanced to each trained man by his society. The worker on the new loom is expected to make more profit than the worker on the old one, as the former, being financed from the start, will be able to buy raw silk for cash price, show greater output in less time, and sell the finished fabrics at market rates. He would, therefore, have no difficulty in paying off by instalments the sum advanced by the society. Another advantage is that the price of the new machine is not prohibitive. The first machine, which was introduced from India, cost Rs. 252. The next, which was made locally on the plan of the first, cost only Rs. 95-6. Subsequent small machines have been set up and cost not more than Rs. 55 each. This, it is believed, is the lowest limit compatible with efficiency.

The sale of the articles produced in the school covers the cost of the experiments and the Co-operative Credit Society is sanguine of success in the introduction of the new loom and its attendant improvement of the industry generally.

A careful study of this interesting subject in all its phases leads one to take an optimistic rather than a pessimistic view of the future of the silk industry in Burma. Instead of declining, as some would have us believe, it is developing in the face of foreign competition, slowly perhaps, but none the less steadily, although as already observed, the weavers labour under great disadvantages.

Two roads to salvation suggest themselves under these circumstances, namely :—

(1) To send chosen Burmese youths, preferably from the weaving class, if available, to Japan for training in the arts of dyeing, twisting, weaving—in a word, in every thing connected with the silk industry.

(2) Or, as an alternative, to engage the services, on attractive salaries, of professional experts from Japan or Europe to teach the above arts to the people engaged in the silk industry. A Central Industrial School could be formed where selected students could be sent for training.

If either of the proposals commends itself to the authorities the officials of the Co-operative Credit Societies will interest themselves in the scheme with their usual whole-heartedness.

THE STRAWBERRY CULTIVATION OF MAHABLESHVAR.

BY

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MAHABLESHVAR, which is the chief hill station of the Bombay Presidency, lies in 17° 51′ north latitude, and 73° 30′ east longitude, 33 miles north-west of Satara, and 75 miles from Poona by road The height of the station above sea-level averages 4,500 ft. and it is situated on one of the spurs of the Sahyadri hills. The average height of the strawberry area is 4,000 ft. The average rainfall is 250 inches, chiefly from June to September, with about 10 inches for the remainder of the year. Woodrow* states that the strawberry gardens get only half of the above amounts on account of their position. The actual amount of the rainfall is, however, not of particular importance in this case, since the strawberries are grown entirely on lifted water, and during the rains the beds are more or less submerged. The average mean temperature is 66·8° F. for the year. The cool season includes the months of November, December, January and half of February, when the mean temperature is 63·4° F. From the middle of February the temperature rises. The hottest time of the year is from about the middle of March till the beginning of May. During this period the day temperature may rise to 90° F. After this, thunder showers usher in the monsoon proper, which begins early in June.

The geology of the hills is simple—trap overlaid by a light capping of iron clay. The soil is therefore of a red colour, and the red dust of Mahableshvar is proverbial. The strawberry area,

* Gardening in the Tropics.

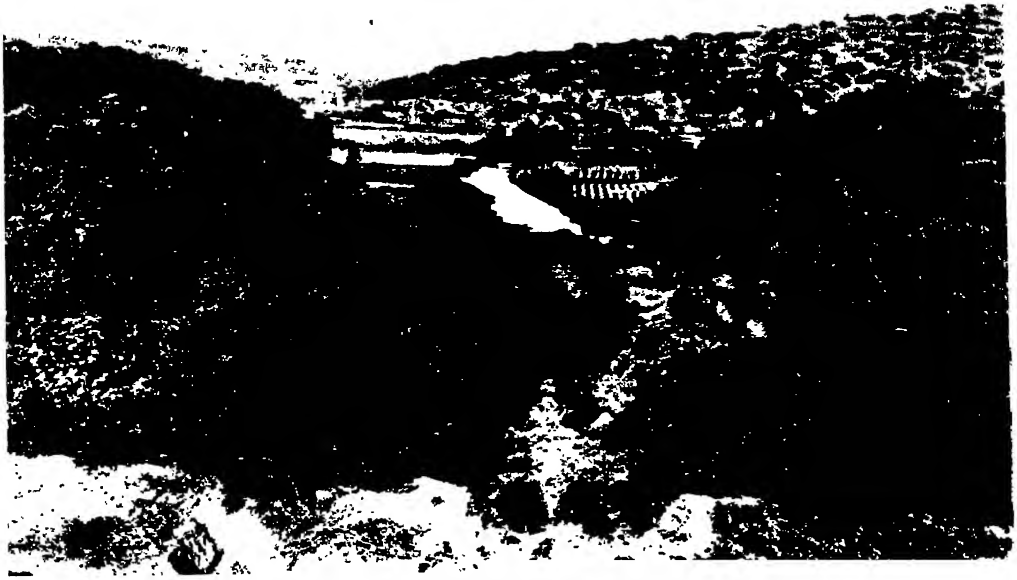

Fig. 1. GENERAL VIEW OF STRAWBERRY AREA.

Fig. 2. STRAWBERRY BEDS.

lying, as it does, in the valley of a river between the hills, naturally has soil of this surface iron clay type, but of an apparently rather loose and friable texture as if there were a fair admixture of sand in it. Since the area is flooded every year, this is to be expected, and since the rains drain through a forest area with a vast amount of natural leaf mould on it, the deposited silt must be fairly rich in plant food, although much is probably swept away to lower levels.

The men who cultivate the strawberries are mostly the Maratha cultivating caste, called Kunbis. There are a few Mussulmans also who have taken up this business. The cultivators not only grow the berries, but as a rule arrange the selling of them, and it is a fact that the larger merchants of the place do not handle the fruit. The cultivators seem well-to-do. and are friendly and not afraid to explain things to a European. It is probable that at least those who hawk the berries in the station get over that suspicion of enquirers which is sometimes found in other cultivators. The men and their families do most of the work, with occasional hired labour at the rate of four annas a day.

Fig. 1 of Pl. XXVII gives a general idea of the place in which the most important beds are situated. This is at the east end of the Mahableshvar Lake, and is a valley through which runs the river Yenna from which the water for the cultivation is drawn. After the flooding has ceased, and the rainwater drained off, usually in the month of October, the land is dug and ploughed, the beds are marked out and the water channels constructed. Manure is applied in large quantity if vegetables are to be put on the land, but in small quantities if strawberries are to be planted. It appears that it is the custom to rotate vegetables, such as French beans and cabbages, with strawberries. In the case of a bed intended for vegetables, farmyard manure is applied at the rate of about one two-bullock cart load (4 cwts. ?) to an area of about 12 × 12 ft. The exact amount applied in the case of strawberries is not ascertainable. Cattle urine is given later before flowering as a top-dressing to strawberries. The plants are set out in the beds at about eighteen inches apart each way, and in beds of varying size, a fairly

common one being with five rows of six plants each. (See Fig. 2, Pl. XXVII). Water is given every five or six days till flowering, after which it is given every second day. Watering is done by an instrument called the *Dhau*. The origin of this name is obscure. It is possible that it came in with the Chinese cultivators who will be mentioned later. Fig. 1, opposite shows one of these *Dhaus*, and the way in which it is worked. It belongs to that class of water-lifts of which there are many in India and which consist of a beam with some kind of a weight, either fixed or moving, to balance against the water in its receptacle. The *Dhau* is made of a strong upright post as a support to another fixed across it as a lever. On one end of this lever is tied a large stone, and to the other is fixed a small bamboo and a bucket. The operator seizes the small bamboo as shown in the photograph, and pulls the bucket down into the water, fills it and allows the weight of the stone to raise the water to the required level, when he empties the bucket into the water channel and starts again. The bucket used is the ordinary one of European manufacture, of galvanised iron, and its handle forms a very useful flexible attachment to the bamboo, so that the operator has no difficulty in pouring the water out. A man using this *Dhau* steadily at a normal rate can deliver 10 bucketfuls a minute, which will work out at about 40 gallons per minute.

The plants usually commence to flower shortly after the middle of January, and berries follow in about three weeks time. The cultivators have a curious and interesting practice of reducing the vegetative growth of the plants in order to promote flowering. This is done by taking off leaves and their axillary undeveloped shoots twice a month. The amount taken off is quite by rule of thumb. A similar taking off of shoots is done before the plants are removed from their beds for transplantation in the villages during the rains. Weeding is done whenever necessary, about twice a month, and the soil seems to get no other stirring than that which it receives in this way. The weeds are to a great extent those which haunt the shores of the lake and the bank of the Yenna. Such are *Polygonum glabrum* and *Fimbristylis æstivalis*. The

PLATE XXVIII.

Fig. 1. THE DHAU.

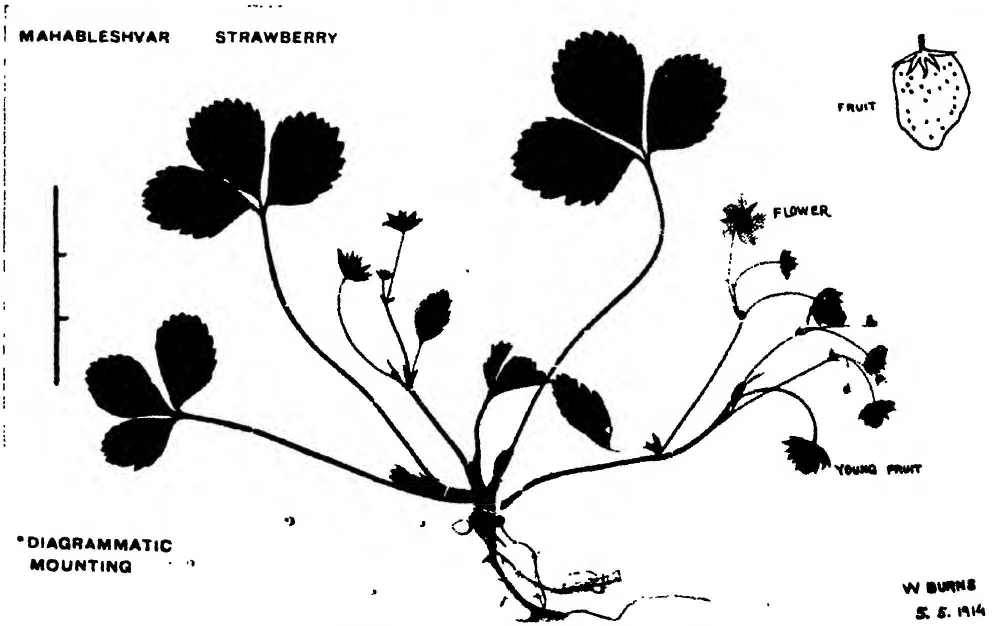

Fig. 2. STRAWBERRY PLANT. Scale on left in inches.

common *Cynodon dactylon* is also present, and the ubiquitous *Argemone Mexicana*.

Flowering and fruiting go on steadily until the rains break. Every morning before 7-30 A.M. the berries that are ready are picked and either taken off to be hawked in Mahableshvar, or packed for transport to Poona or Bombay. The hawkers carry the berries in shallow baskets slung at the end of a pole carried over the shoulder. There is no fixed price for the berries in any of these places, but the rate is more or less the result of private haggling. In April and May the price of the berries in Mahableshvar itself is about four annas per hundred, in Poona about a rupee per hundred, and in Bombay as high as six annas a dozen for first class berries and four annas for second class. For transport to Bombay and Poona the berries are gathered while still unripe, with the yellow colour visible and the consistency still hard. They are packed in baskets called *karandis* or *karandas*. which contain from 14 to 16 dozen fruits. Packing is done with cabbage leaves or moss. From the beginning of the fruiting till the commencement of the Mahableshvar season, *i.e.*, up till April 1st, the number of *karandis* carried to Poona is between 25 and 30. and to Bombay between 75 and 100 daily. From April 1st till the rains the numbers are from 20 to 25 to Poona. and 40 to 50 to Bombay, but in the latter case the consignments are practically all private ones. The rates for transporting these fruit parcels. as charged by the Government mail contractors, vary according to the weight of the parcels, but as a *karandi* generally weighs below 5 lbs.. each is charged at six annas a parcel, either to Poona or Bombay. The parcels are conveyed by motor to the station of Wathar, 40 miles by road, thence by rail to Poona (about three hours' train journey), or to Bombay (seven to ten hours' journey). In Poona the berries are hawked from door to door by the friends of the growers, and in Bombay the berries scarcely appear in the public market but are sold by hawkers in the railway station. From these facts it will be seen that from the commercial point of view the demand is much larger than the supply and there is an excellent future, especially in Poona and Bombay, if the supply can be increased and delivered

in good condition. The statistics of profits and loss on individual plantations are most difficult to get, and so far there is nothing definite known on this point. The actual number of berries produced from a given area has never been computed, and until this is done, there is no basis for calculation. Nevertheless, the trade seems to be a very profitable one, especially since there is not much to be paid in the way of middlemen's profits.

The history of strawberry introduction into Mahableshvar is somewhat obscure as to details, but the following seem to be the broad facts. About 1830 Chinese and Malay convicts were accommodated in a jail in Mahableshvar. Some of these were allowed to grow vegetables. There is no absolutely authentic statement that strawberry cultivation originated with them, but this is the common report and is probably correct. There are no Chinese now in the station. The local cultivators seem to have learned a lot from the Chinese and this information we probably see especially in such practices as the reduction of the vegetative growth of the plants. The origin of the berries originally cultivated by the Chinese is obscure, but Saharanpore is mentioned as a possible source. The original berries were small and not very good. Professor O. V. Muller, Professor of History in the Elphinstone College, Bombay, informs me that in the wet famine year about 1896 the strawberries were all washed away. A rainfall of 401 inches was registered at that time. In October of the same year a public subscription was raised to restock the beds, and runners were first ordered from Saharanpore, but did not stand the journey. Some of the strawberry cultivators then went personally to Bangalore from which place they brought back the ancestors of the present race of berries in Mahableshvar. The still more remote origin of the Bangalore plants is unknown.

The present characters of this race are as follows. Each plant, in May, in a normally treated bed, has dimensions of about 8 inches height and 10 inches spread. The base of the plant in the soil is narrow, only about $1\frac{1}{2}$ inches in diameter. This however is an outside measurement including the bases of all shoots, and the actual rhizome in the centre does not measure more than about

half an inch in diameter. This rhizome is roughly spherical and pointed downwards. The roots are numerous, adventitious, 4 to 6 inches long, and in a dense mass. The nature of the leaves is shown in Pl. XXVIII, Fig. 2. The stipules at the base of the leaf-stalk measure $\frac{3}{4} \times \frac{1}{4}$ inch and are membranous, white with green veins, and acute at the tips. The leaf-stalk varies in length from 3 to 6 inches, is channelled on the upper side, and sparsely clothed with simple white hairs. There are three leaflets, each about $1\frac{1}{2} \times 1$ inch, with a stalk of about $\frac{1}{4}$ inch. The middle one is obovate with acute base and four to six teeth on each side of the tip. The side leaflets are similar, but the outer side of each is much the bigger, and the leaflets are consequently oblique, with the teeth extending much further down the outer side. The upper surface of the leaflets is deep green and devoid of hairs. The lower is smooth and shining, and pale green. Short hairs appear sparsely on the projecting veins on the lower surface. The bearing branches are cymes springing apparently direct from the rhizome from between two opposite leaves. A bearing branch is shown in Fig. 2, Pl. XXVIII.

The flower has a calyx and epicalyx, the total number of the members of which varies from 10 to 15. The petals are five, white, and the flower is $\frac{3}{4}$ inch across. Each petal is nearly circular tapering a very little towards the centre, and $\frac{1}{4}$ inch in diameter. The fruit is variable in size, from $1 \times \frac{3}{4} \times \frac{1}{2}$ inch to $1\frac{1}{2} \times 1 \times \frac{3}{4}$ inch, but is in every case tapering towards the apex as the sketch in Pl. XXVIII, Fig. 2 shows. When ripe the berries are a deep crimson, and are apt to have irregular depressions on them. On cutting a berry longitudinally a white central core is seen, which is of varying dimensions but seldom less than a third of the total diameter. The rest of the flesh is also white, except for a slight flush below the skin.

As cultivated and sold at present, the berries, though good, are capable of considerable improvement. Ripe or almost ripe berries will not last half a day in Mahableshvar, and some more lasting fruit is desirable. The berries at present deliquesce. This may be due, to some extent, to the berries being gathered in the early morning when they often have dew on them. The berries themselves

are rather watery and this may also favour the deliquescence and certainly interferes with the flavour. Dirt from the fields is often found in small hollows of the fruit, but it is practically impossible to prevent this. It would be worth while seeing if the berries would thrive better and get less dirt also if grown on small ridges, so that the water did not actually touch the plants. At present the berries are grown on a flat surface and the water flows all round each plant. It is probable that something could also be done to improve the packing and transport, but this would need a very careful investigation of the local materials available, and remarks on this at the present moment would be out of place.

It will certainly be worth while to try other races of strawberry from Europe and America, for at the present moment there is only the race above described in the station. It may be that the new races if imported will change, but it should be possible finally to get a better race than the present which though good is not ideal. It should be mentioned that the plants do not produce runners very freely in the field. Each rainy season the plants are transplanted into a small plot of ground in the owners' village, probably in shelter, and are kept there till the following planting time. There seems to be no regular trade in plants, but one man will buy the plants of a certain bed from another at a price agreed on after discussion.

Whether the cultivators would be willing to try new plants in such a way as to give them a chance one cannot say, and the first two years of the new introduction would certainly have to be most carefully supervised. If this can be done, there is a likelihood of a successful future for high-class strawberry cultivation in the Yenna Valley.

SUBSOIL DRAINAGE IN PADDY LANDS.

BY

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A short account of the experience gained in laying down subsoil drains in paddy land may be useful to others who wish to introduce subsoil drainage in some form or other. Although the question has hardly reached the stage of recommendation, a certain amount of information has been collected on the durability and utility of such drains.

The land chosen for the experiment was about 1½ acres in extent, and was part of the wet* lands of the Central Farm. The peculiar system in which this crop is grown, is not affected by excess of water and it was more in the hope of reducing the alkalinity from which this land suffers, by passing the water through the soil and away by the drain, that the experiment was carried out. The rise in the water table was due to the higher level of the water in the adjacent tank, and is sufficient to keep the land immediately below the surface wet all the year round.

Eight drains were laid in all: each drain had a length of 400 feet, and a fall of from 1·35 to ·7 feet. The drains were 21 feet apart, necessitating a total length of 2,074 running feet per acre.

Two kinds of drains were used; one, a plain loose stone one, the other made of bamboo tubes. The cross sections of the two are shown in the accompanying diagram, from which it will be seen that the drains were 2′ 6″ deep at the bottom: the stones being filled in to a breadth of 1′ and a depth of 6″. The bamboo drains were also packed in stone to a depth of 6″. These bamboo tube drains (Fig. 1 below), were simply bamboos of about 3″ bore, cut at the internodes into lengths about 1′ 3″; the diaphragms were then

* Wet lands are those which receive copious flow irrigation during the paddy season, in this case, from a tank. The land is puddled and the paddy grown under swamp conditions.

Fig. 1.—Bamboo Tile Drains.

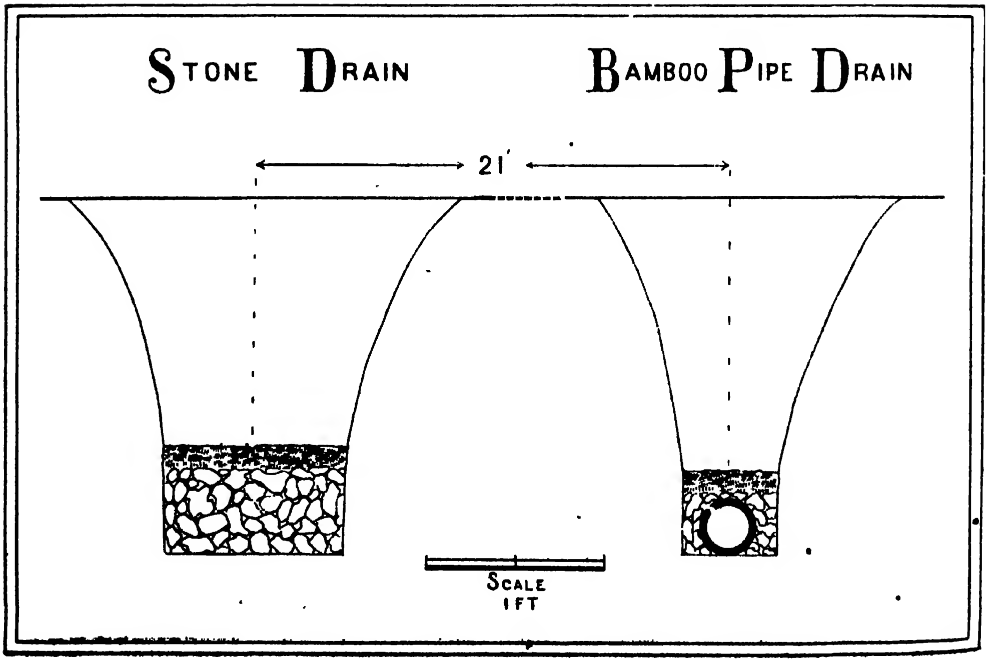

Fig. II.

removed by a carpenter and the whole piece dipped in tar. They were laid end to end, being threaded up on long thin bamboos. The cost of this work was as follows :—The stone drains cost 8·82 pies per running foot, the bamboo drains, 10·14 pies, which works out to Rs. 95-7-3 and Rs. 109-11-10 per acre respectively. Of course, the relative as well as the actual cost will depend very much on the locality : probably the stones at Coimbatore were cheaper than they would be in many places where such work would be done.

The drains were laid in the summer of 1910, under the supervision of M. R. Ry. R. V. Subramania Aiyar, the Engineering Assistant of the College, and after three years' cropping, have recently been examined. All the outfalls have needed occasional clearing, and were at the time of examination running fairly strongly. One stone drain was probed 15 yards from the outfall, and immediately a rush of water ensued, which seemed to indicate that the water was under pressure, an interesting commentary of the impervious nature of the soil. A bamboo drain was then examined. The bamboos were found in a very good state of preservation, but were blocked in several places. This was due to silting, a process which had been assisted by the displacement of the pipes and the inadequate fall, which in one case was only ·7 foot in 400 yards.

Bamboos are thus found to be feasible in such wet soil and may be expected to last for several years. Great care must be exercised in laying them ; it will be seen from the photograph that the water was actually standing in the trenches when the pipes were laid. This was due to the delay in putting them down : had they been in a month earlier the work would have been better done. The slope is however the main difficulty, since on this class of lands a considerable fall is seldom available : while the smaller the fall, the more uniform must be the pipes and the more careful the laying. That these drains have resulted in an improvement in the land, there is little doubt. Some of this, especially at first, may have been due to the thorough trenching which the land received in the process of laying the drains, but it would not have been so prolonged. A more alkaline piece of land has now been chosen for further trial, since if such land can be reclaimed at Rs. 100 an acre, it would show

a very large profit. The drains will be laid with a greater fall, and some modifications adopted in the method of using the bamboos. The thin bamboo used to thread the sections on will be dispensed with, and in order to get fewer joints and use some system of 'collaring' these joints, a method of splitting the bamboos lengthwise and binding them up with wire after removal of the septa, will be tried. The difficulty will lie in obtaining bamboos sufficiently straight for the purpose.

It may not be out of place to close this note with a reference to previous Madras experience of underdrainage. A continued series of experiments were carried out at Saidapet by Mr. Robertson in 1873. Stone drains and tile drains were both used, and were laid 24 feet apart and 3½ feet deep. After 5 years the drains were exposed and were found to be silted. A further experiment in 1875 which lasted till 1878 produced the same result. The pipes were only 2" in diameter and were laid with a very slight fall, conditions which would both tend to an accumulation of silt. The cost was Rs. 30 per acre. This land was redrained; the tiles being 'collared' and silt traps being laid in the main drain, but without effect, the tiles became again silted. The general conclusion was "the results of the above experiments are decided as regards the benefit which subsoil drainage does to the soil, but as regards the means of carrying out such a system, in this country, much more experience must be collected."*

More recently experiments have been made on the Home Farm, Sivagiri, whence M. R. Ry. A. Rama Row reports that stone drains were laid down in clayey alkaline paddy land and have been running well for five years to the marked improvement of the land. It is in this direction that there is most prospect of success. The high value of paddy lands, and the fact that alkali lands when reclaimed are usually fertile, together with the large quantities of water used in the cultivation of this crop, are all factors making for financial success.

* Records of the Saidapet Experimental Farm.

THE NAGPUR CO-OPERATIVE DAIRY

BY

D. CLOUSTON, M.A., B.Sc.

Deputy Director of Agriculture, C. P.

As the Nagpur Co-operative Dairy has only been working for eighteen months, it would be premature to attempt to draw definite conclusions that would be of general application to similar dairy concerns in India from the results obtained up to date. This article, written at the request of the Editor of the *Agricultural Journal of India,* will therefore aim only at giving an account of what has already been done and what it is hoped in future, to do at this particular dairy.

In the town of Nagpur there are supposed to be over 3,000 cattle belonging to people engaged in the milk trade, of which about 1,700 are milch-cows and buffaloes. The trade is mostly in the hands of professional *gaolies*; but many cows are also kept by Kunbis, Telis, Brahmins and other castes who combine cow-keeping with tonga-hiring or some other occupation. The bulk of the owners have no grazing area : their cows are allowed to wander here and there in search of food. By day hundreds of them may be seen wandering through the bazaar picking up edible rubbish or stealing mouthfuls of food-stuffs from unwary merchants. At night they make a raid on the compounds and gardens of the civil station, where they do enormous damage to the produce thereof. The *gaolies* are thus constantly getting into trouble with the municipality, with the merchants in the bazaar, and with the owners of gardens in the civil station.

The quality of their milch stock is very poor owing to bad feeding and the absence of any system of selection in breeding.

The average milk yield per day for a cow during her whole lactation period is about two seers, and for a buffalo four. The amount of bulky fodder and concentrated food-stuffs fed to animals in milk is comparatively small : some *gaolies* give their dry stock none at all. The result of this is that, depending as they do entirely on the meagre grazing available, they get very weak and emaciated in the hot weather. The *gaolies* as a class are badly in debt, and have to pay exorbitant rates of interest to their *sowcars*. The average man, with his small herd of five or six milch animals mortgaged to their full value, ekes out a precarious existence. His annual net income is probably little more than that of a cooly labourer.

The supply of milk in Nagpur is far short of the demand, more especially from March till July, during which time many milch animals are dry or nearly so. The price of pure milk in the bazaar during this period is from 4 to 5 seers per rupee : the price for the rest of the year is from 6 to 7 seers per rupee. But it is difficult to get pure milk even at these prices, for the *gaoli* is skilled in many tricks by which he can adulterate it without much chance of his being caught in the act. The conscientious memsahib who gets him to milk his cow in front of her is not always sufficiently lynx-eyed. In the event of her failing to inspect his milk *lota* (brass pot) before milking is begun, he will have it half full of water to start with, so that he reverses the usual method of adulteration and adds milk to the water which is already there.

Another aspect of the dairy question which condemns the present primitive system of milk supply is the insanitary conditions under which milch animals are kept in the bazaar. They are huddled together in small houses, in populous centres where dust and a most disagreeable stench are the outstanding characteristics of the environment. They drink at scum-covered pools and in their hunger eat such foul scraps as they can pick up in the streets. An official who recently investigated the existing condition of the milk trade in a certain military centre in these Provinces, found that the *gaolies'* cows and buffaloes were fed at times on horses' dung, and that their *panchayat* insisted that no

member of their fraternity should supply *unadulterated* milk to customers.

The Nagpur Co-operative Dairy was started with the following objects in view :—

(*a*) To get a reliable supply of clean and pure milk for distribution to the public, by keeping the dairy cattle under sanitary conditions and by preventing adulteration.

(*b*) To form a co operative society of *gaolies* whereby their credit would be strengthened and their working expenses reduced.

(*c*) To improve the quality of their milch stock by selection, crossing and better feeding under expert supervision.

The site selected for the dairy farm was Telinkheri Hill two miles from Nagpur, where there was an existing cattle-breeding farm on which cattle of the Gaolao breed are kept. An area of about 100 acres was taken over from the breeding farm for the dairy farm and an additional area of about 800 acres was acquired, about half of which is kept for hay, while the other half is open for grazing. The soil of the greater part of this area being thin and stony produces mostly spear grass (*Heteropogon contortus*).

When grazed before the spears form, this grass is palatable; after November it dries up and by March not a single green blade is left. The area overlooks a large tank of clean water on the flanks of which are two small tree-clad valleys. In these there is a deeper soil producing green grass which outlives the drought of the hot season. Iron sheds have been constructed by the department for the accommodation of both the milch and dry stock of the *gaolies*. They are supplied with concentrated food-stuffs purchased wholesale by the department and with hay, *juar-karbi*, green fodders and ensilage produced on the Telinkheri Seed Farm, at rates which are about 25 per cent. less than those prevailing in the bazaar. The *gaolies* have at present 131 milch cattle and 90 young animals on the Dairy Farm. They are charged a grazing rate of As. 4 per head per month. The whole grazing area is fenced, so that their stock are never allowed to get outside the farm limits to mix with other cattle. The average cost of keeping their cows and buffaloes when in milk is Rs. 4-2 per head per month : this includes grazing. The

cost of keeping their non-milking stock, including young stock, averages about As. 7 per head per month.

Their cattle are milked in their sheds by the *gaolies* themselves under the supervision of our dairy staff, consisting of one overseer on Rs. 60, one *kamdar* on Rs. 15 and three *chowkidars* on Rs. 8 each, who see that the milk is not adulterated and that the dairy utensils supplied by Government are kept thoroughly clean. The Government Cattle Breeding Farm, and dry stock of the *gaolies* are under the management of the same staff. The milk is handed over to a contractor who has constructed an up-to-date dairy with all the necessary appliances for distributing the milk in bottles, twice daily; for separating the milk when there is a demand for cream, and for making butter when there is any milk to spare for that purpose. The contractor takes the cows' milk at 8½ seers for the rupee and buffaloes' milk at 8 seers and delivers it to his customers at 6 seers per rupee. This margin of 2 and 2½ seers per rupee is supposed to cover the cost of distribution and to leave a fair profit on the capital expenditure of about Rs. 5,000 incurred in constructing and furnishing the dairy. The dairy, supplying as it does milk handled under most sanitary conditions and delivered regularly morning and evening to its customers, has added in no small degree to the amenities of life in Nagpur. It is to be regretted that its output of milk being comparatively small, it has not yet been possible to meet all demands.

It is exceedingly difficult to get *gaolies* to co-operate with any degree of success as they are so heavily indebted and so averse from honest dealing. As a class, they are very dishonest; they cheat, as their forefathers did before them. If they had been honest they could not have made a living in the bazaar: the fittest in the struggle for an existence have survived. One of the aims of the Nagpur Co-operative Dairy was to ascertain how far dairying by such a class could be made to fit into a co-operative dairy scheme. The number of members in the Society at present is 13. The Society is financed by the Nagpur Central Bank which has advanced the members Rs. 2,000 for

the purchase of dairy animals and provides a monthly loan of Rs. 100 for petty expenses. It was at first very hard to get the members to conform with regulations. A former Director of Agriculture pithily describes their dishonest devices in the following words :—

"Dishonesty is in their blood, or perhaps one ought to say in their milk ; they grumble at every thing ; they pilfer from the fodder stacks ; they require a lynx-eyed supervision at milking time ; they demand full grazing and the dung of their animals, and their intelligence is such as to render them peculiarly impervious to reason."

For the first year this description was true enough to life, for they were constantly grumbling, disobeying orders and getting into trouble with the farm staff. In order to allay discontent and to strengthen the spirit of co-operation all round, it was decided to hold a meeting of the Society once a month so as to give both the members and our staff a chance of airing their grievances against each other in front of the Deputy Director of Agriculture. This system has worked very well ; the *gaolies*, as the result of firm but sympathetic treatment, have become much more amenable to reason and are very much more contented too. A regular system of rewards and fines has been devised. A member caught watering his milk is fined Re. 1 for the first offence, Rs. 2 for the second, and Rs. 5 if the offence is repeated. For every animal caught outside the grazing area the owner is fined As. 4, and so on. The *sirpanch* of the Society is asked to fix the amount of the fine for each offence ; but some of these would-be law-makers have themselves had to be fined for offences committed. The fine money for each month is given as rewards to those who have not strayed in crooked paths during that month.

That they can now borrow money for the purchase of milch animals at the low rate of 9 per cent. and that they can purchase food-stuffs at wholesale rates are no doubt great economic advantages to a class of men who are poor and in debt. On the othe hand, they are not paid so much for their milk as they used

to make out of it by dishonest devices when each individual sold his own supply. Being relieved of the work of retailing it from door to door, does not mean much to them, as they have no other occupation to take its place ; still it is believed that in the long run they will profit very considerably by belonging to the Society, because membership offers scope for building up an improved milch stock at a minimum cost to themselves.

The improvement of their milch stock has been taken up on very definite lines. The introduction of clover as a fodder crop makes it possible to supply them with this green luscious food-stuff from the middle of November till the middle of April. From the middle of April till the middle of May, they get clover ensilage and from May till the end of July green juar, maize and sann-hemp. All these green fodders are supplied at the rate of 240 lbs. per rupee, at which price their cost as milk producers is less than half that of the concentrated food-stuffs which they have been accustomed to use.

Their milch buffaloes are being crossed with a bull of the Delhi breed which should give rise to a better milking strain than they have at present. The department has a herd of 2 Delhi and 7 local milch buffaloes. In a year or two it is hoped to have a fine large herd of buffaloes, from which members of the Society will be supplied with cows at moderate prices. The department has also selected 12 of the best milch-cows from the Telinkheri herd of Gaolao cows. These have been crossed with a bull of the Montgomery breed from the Pusa herd. The crosses produced will be tested as dairy and draught animals. Crossing with a bull of the Ayrshire breed is also being started ; a pedigreed Ayrshire bull has been obtained from home for this purpose. It may be mentioned here, however, that cows of the Hansi and Montgomery breeds from Northern India do not do well in the Central Provinces. The excessive dry heat, and the lack of decent grazing from December till August, finish off all but the very strongest of these animals in about two years. With the results of these experiments in crossing to improve the milk yield, combined with better feeding and housing, and

better arrangements for the segregation and care of sick animals, there is every possibility of being able to improve the *gaolies*' milch animals.

The total quantity of milk, cream and butter supplied by the whole dairy from the 1st of June 1913 till the 31st May of 1914 was 150,230 lbs. of milk, 109 lbs. of cream, and 140 lbs. of butter. Of the total quantity of milk, the Society supplied 113,850 lbs.

For food-stuffs and grazing the members have during the year paid Rs. 3,630-10-11 : for their milk which they have handed over to the contractor they have been paid Rs. 6,772-3-6 : they have within the same time paid back Rs. 1,541-12-5 of the money borrowed from the Central Bank. The total net profit of the Society for the year has therefore been Rs. 3,141-8-7, but this considerable profit is largely due to the fact that the Society has been supplied with green fodders, hay and *juar-karbi* at low rates, and that it has not been debited with the cost of supervision.

Under existing conditions, handicapped as they are by poor milch stock, by heavy load of debt and a double dose of original sin, real co-operation among *gaolies* unaided by Government would be impossible. The writer is convinced, however, that the dairy industry could be made profitable in towns like Nagpur where irrigation is available, if run on purely commercial lines. From the figures obtained from the Government herd on the Dairy Farm the following conclusions have been drawn :—

(*a*) that given a dairy of 100 cows of the Gaolao breed managed by one overseer on Rs. 60, a *kamdar* on Rs. 15, and 6 milkmen on Rs. 10 each, and a grazing area similar to that of Telinkheri Hill, where the grazing dues were till lately As. 8 per month for milch animals and As. 4 for stock, the total loss, after allowing for interest on capital and depreciation of stock, would be about 1 per cent. ;

(*b*) that the working of a dairy with a herd of 100 local buffaloes kept under the same conditions would give a little over 5 per cent. ; and

(c) that with the dairy herd of 100 Delhi buffaloes the profit would amount to about 8 per cent. These profits could be largely increased by improving the milch stock and by substituting green fodders to a still greater extent for concentrated food-stuffs; this can only be done gradually. The cow of these Provinces is not worth its place as a dairy animal.

While a dairy run by a private individual or by a joint stock company with ample funds at their disposal could, for reasons already given, be run more economically and with more satisfaction to its customers, than a co-operative dairy with *gaolies* as members, still as the industry is in the hands of this class at present, it is the duty of Government to help them to help themselves. This can best be done on the lines on which the Nagpur Co-operative Dairy is being worked, where full use is made of the *gaoli*, but which at the same time aims at demonstrating to him ways in which he can improve his lot. While it is not sure that the problem of Indian urban milk supply will find its ultimate solution in private or co-operative dairies situated in areas just outside the city, such is at any rate the best solution of the immediate problem, and the best adaptation to present needs, of the existing means of supply.

NOTES

Cotton Seed Distribution in Egypt.—In the April number of this Journal an interesting article was published on "The Establishment of cotton markets in Egypt" by Mr. Smart, Director of Agriculture, Bombay. With regard to this and similar co-operative schemes, there is an article on "The distribution of cotton seed by the Department of Agriculture in Egypt," published in the *Agricultural Journal of Egypt*, 1913, which should be of great interest. This deals with the selection of the best seed for sowing and its successful distribution to the *fellahîn* or small cultivators. There are two schemes: (1) the distribution of good *Taqâwi* (seed for sowing) to small cultivators; (2) the supplying of selected *Taqâwi* grown on the States Domains to the largest and most careful cultivators in the country, with a view to utilising 50% of the yield for distribution under scheme(1). The first is known as the "ordinary distribution scheme" and the second as the "States Domains seed distribution scheme."

The difficulty with regard to the first scheme was to supply a sufficient quantity of good seed at a low enough price to enable the cultivator to buy it, and to do this it was necessary to organise the better cultivators and larger farmers and encourage them to assist the Government for growing the best seed for distribution to the *fellahîn*. In order to get the *fellahîn* to accept Government seed he had to be allowed credit on easier terms than he could obtain from dealers and this has necessitated a great deal of organisation and collection.

The scheme which is now in its third year appears to have thoroughly caught on, and as the Government are able to increase their supply of good seed for distribution year by year, so the price

will automatically drop until all inferior seed is squeezed out of competition. The distribution on credit was limited to those who cultivated eight feddâns (a feddân = 1 acre roughly) or less, and the seed was distributed in a special sack sealed with a leaden seal. This sack had to be returned to prevent its being refilled and sold full of inferior seed the following year. Special sub-inspectors toured the districts and visited the villages to explain the scheme.

Particular emphasis is laid on the fact that the Government does not pretend to supply the best selected *Taqâwi* to the smaller *fellahîn*, but only a good *Taqâwi* which is obtained from first class ginners who get it from (*A*) crops which they have purchased; (*B*) crops which have been inspected in the field and recommended by the department's inspectors. By means of these two schemes it is hoped to have the cultivators well in hand by the time the pure seed types on Mendelian lines which are being bred on the experimental farms become available for distribution. The course of the next 3 years should see them available and then the improvement of the crop will be rapid.—(WYNNE SAYER.)

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THE VALUE OF INDIAN SOY BEANS.—The following report of a firm of manufacturers of soy bean products has been received through Messrs. Stuart R. Cope, London, and deals with the two typical varieties of Indian soy beans referred to on page 392, of Vol. VIII, Part IV of this Journal. It will be seen that the Nepali type compares very favourably with the beans exported from Manchuria.

"According to the oil tests we find that 'type IV' would be worth to us from 7/6 to 10/ per ton less than the ordinary Manchurian beans.

"On the other hand, we find that the Nepali beans are quite equal to or might be perhaps considered 2/6 better value than the ordinary Manchurian beans.

"We think these beans would be suited to our process and the question would be merely one of price.

"With the valuations we have put upon them we shall be quite prepared to receive offers of reasonable large quantities."—(E. J. WOODHOUSE AND C. S. TAYLOR.)

THE IMPROVEMENT OF SALINE LAND.—A piece of wet land (0·20 acre) was sown with one Madras measure (3 lbs.) of *dhaincha* (*Sesbania aculeata*) broadcast during the first week of March, 1913, just subsequent to the harvest of paddy after once ploughing with the moisture available. A second ploughing cross-wise was done in order to cover the seed. There was a successful germination; and the plants branched profusely and grew to a height of 10 feet in a little over 6 months. The plot became flooded with stagnant water during the season, that is, at the beginning of the latter half of September; and after 4 days. the stems became shaky and were pulled out with some difficulty. In the meanwhile, a good quantity of leaves had been shed on the ground and the few leaves that remained were also stripped off while pulling and strewn over. The overgrown stems with their roots and branches were sold for fuel after collecting seeds of which 30 Madras measures (90 lbs.) were obtained.

In addition, 4 cartloads of finely decomposed stable-refuse were applied. Trimming bunds and corners and ploughing in puddle 4 times over, were the only further operations resorted to. This process not only resulted in the complete removal of any the least alkalinity in the soil, but increased the outturn of the plot in question from 75 lbs. of paddy in the previous year to 450 lbs. this year. The physical character of the soil has also been much improved since the roots of the *dhaincha* were found to have gone down to a depth of a foot and a half, thereby rendering drainage more free which is the chief desideratum in all alkaline, clayey lands.—(T. V. S. CHARLU.)

***

A SUCCESSFUL CURE OF SPONTANEOUS EQUINE SURRA, BY THE ADMINISTRATION OF ATOXYL AND ARSENIC.—At the direction of Major Smith, Principal, Bengal Veterinary College, the writer has

been able to cure successfully a case of spontaneous equine Surra following the lines suggested by Major Holmes, the Imperial Bacteriologist. Captain Dawson stated in the *Indian Veterinary Journal* that Dr. Gibson, Director of the Vaccine Institute, India, tried the treatment with success and Mr. Gaiger also succeeded in curing a few cases in the Punjab; but as this is the first case of cure reported from this province, it would be interesting to place it on record.

The subject was a country-bred gelding in debilitated condition, the property of an Indian gentleman. The animal was admitted into this college hospital on 17th October, 1912, for treatment of bilious fever with a temperature of 102·3° F. The treatment started with an administration of a purgative ball, later on followed by cholagogues. They apparently had no beneficial effect on the patient. On the 22nd morning the temperature went up to 104° F. and the blood was submitted to a microscopical examination with the result that large numbers of trypanosomes were detected. It was then decided to attempt the treatment by Atoxyl and Arsenic which proved so very successful in the Imperial Bacteriological Laboratory. The animal was kept in the hospital for about 5 months after which it was discharged cured. Since then the animal is occasionally inspected at the owner's place and appears to show no signs of ill-health and has been regularly performing his usual work. During the course of treatment it received a diet consisting of 4 lbs. of gram, 4 lbs. of oats, 6 lbs. of bran besides plenty of straw and hay and green grass and had exercise for 4 hours a day. Any suspicious symptom of poisoning was meanwhile attended with scrupulous care.—(S. N. MITTER.)

***

The Agricultural Gazette of Tasmania for February, 1914, has a short article by Mr. Johnstone on "Variations in the Cream Test," in which the author says that practically all the causes of variations of cream test are due to the conditions under which the milk is separated. Warm milk separates more completely than cold, and it has been found that the loss of butter-fat in the skim

milk is much greater when cold milk is separated than when it is machined immediately after being drawn from the cow.

When a separator is first purchased its capacity should be ascertained, and also the number of revolutions of the machine required to economically centrifuge the fixed number of gallons per hour. This is said to be very important, as running through a greater quantity than the machine is rated for will produce a thinner cream. Should the machine's capacity be reduced by checking the inflow, a thicker cream is the result, and also a loss of fat in the skim milk.

The correct speed of the handle should always be maintained, and an even pressure kept up all the way round, as smooth running is essential to economic separating.

A lower speed than normal causes a loss of fat in the skim milk, while a higher speed tends to set up vibrations, which interfere seriously with the centrifuging of the contents of the bowl.

Variation in the cream test is also caused by using an uncleaned separator. As a rule the machine should be cleaned after using. Different amounts of water used to flush the bowl after using has also a very appreciable effect on the cream test. Feeds or feeding are said to have no influence on the richness or otherwise of the cream, though an abundance of feed judiciously given will increase the quantity of milk and consequently the amount of cream.—(EDITOR.)

REVIEWS

COCONUT CULTIVATION BY H. L. COGHLAN AND J. W. HINCHLEY. (Messrs. Thacker, Spink & Co., Calcutta). Price : Rs. 2-10.

FROM time to time murmurs are heard of the boom in coconuts which is bound to come, and from time to time books are published drawing the attention of capitalists to the possibilities of coconut cultivation. Such books are seasonable, for with the improvements in deodorizing processes there is a great future before the vegetable oils as food substitutes (*e.g.*, margarine and nut butter) as well as in soaps. But in this field coconut has no monopoly as it will have to meet increasing competition from other oil-bearing fruits and seeds. It is therefore unfortunate that the titles of such books are often misleading. One of the more complete books on coconut cultivation is entitled 'Coconuts'—the "Consols of the East," which conjures up the idea of estimates of profit, though in fact these form only a small portion of the work, while the small publication under review issued with the general title of "Coconut Cultivation" is restricted to Malaya, the land of rubber and tin, and is largely taken up with estimates of profit. It suggests returns of from 24 per cent. to 32 per cent. and more from the seventh year of planting onwards, and for the man who also undertakes the local manufacture of oil and coir rope returns of 100 per cent. from the first year of working. Such estimates invite criticism and whilst an examination of the detailed figures might well be left to a resident in Malaya, it is noteworthy that insufficient stress is laid upon the need for that constant close attention which coconuts require if the average yield of a plantation is to be maintained, that no mention is made of the fact that already many of the estates in Malaya are dependent on South Indian labour and that the competition to obtain that labour, whether in Malaya, Ceylon, or Southern India itself, is annually becoming more severe, and that the susceptibility of the coconut to disease

is passed over comparatively lightly. It makes no reference to the other coconut producing countries of the East, though the *copra* from Ceylon and Malabar has often led the market. The information about cultivation is sound as far as it goes, but there is not much detailed guidance. There is no mention of the ranges of temperature and elevation possible for coconuts, no mention of varieties among coconuts. In fact, from a perusal of the book one would infer that there were no differences at all among coconuts. The local Malayalan method of climbing the trees by cutting notches in the trunk is not one to be recommended. But these defects may perhaps more fairly be attributed to the title by which the book is described. There is no doubt that the industry is experiencing a time of good prices which promises to continue and, viewed as a guide to a planter in Malaya contemplating floating a company, this book contains concisely and conveniently arranged a number of useful tables, *e.g.*, trees per acre at different distances, possible profits per acre at different selling prices of *copra*, rates of export, duties in the Straits, and an abstract of the rules under which the Stock Exchange will grant quotations, etc., much of which will be useful to planters in other countries for purposes of comparison, but it is not a complete guide to " Coconut Cultivation."—(D. T. C.)

***

THE USE OF EXPLOSIVES IN AGRICULTURE. Bulletin No. 8, published by the Department of Agriculture, Ceylon.

Mr. H. F. Macmillan has published the results of some tests of the use of explosives in Ceylon. *Soils.*—On exploding single cartridges at 2 ft. deep, it was found that fissures extended about 3 ft. laterally and made a cavity some 15 inches diam. The effect was not widely different in different classes of soil. *Tree stumps.*—Two experiments on the stumps of " Wa " trees failed in a great measure ; for one 15 cartridges and for the other 10 cartridges were used in addition to a number of detonators. The cost in one case was Rs. 2-3-0, and coolies had to be employed to cut away the roots.

The bulletin gives good illustrations and instructions for the use of these explosives.—(J. W. L.)

PUBLICATIONS OF PROVINCIAL AGRICULTURAL DEPARTMENTS.

Year-book of the Punjab Agricultural Department, 1914 (*Price Re.* 1-4).—In the Preface to this Year-book the Director of Agriculture says :—" This is the first year of the publication of the Punjab Agricultural Year-book. It is intended to supply information as to what the Agricultural Department is doing and to answer some of the elementary enquiries which are constantly addressed to us."

The book opens with a calendar of events of agricultural and general interest in the Punjab, followed by particulars of the Lyallpur College and a general account of the work in progress at Lyallpur and Gurdaspur.

Separate chapters deal with important subjects.—Wheat, Cotton, Cotton Boll-worm, Implements, etc.

***

Sugar in the Punjab—Progress Report for 1913, by J. H. Barnes, B.SC., F.I.C., F.C.S., A.R.I.P.H.

This report is a continuation of that issued in 1912 relating chiefly to the canes of the Gurdaspur district of which it is hoped to complete the survey in the coming season.

To the general public, perhaps the most interesting facts given in this report are those relating to the effect of a short frost on canes analysed at intervals throughout the ripening period. This effect is shown in diagrams at the end of the report relating to 18 canes. It appears to vary very much with the variety of cane and the damage seems to be not always irretrievable.

The author says :—" The suggestion of Stubbs that frost kills the cane cells does not appear to be borne out in my results which seem rather to indicate that the enzyme responsible for sucrose synthesis becomes inactive at the lower temperature, and that *invertase* then comes into operation. The recovery of the cane after the frost has ceased is indicated by a reversal of the process. This is not incompatible with Craft Hill's results on the reversible nature of the inverting action of *invertase.* In

connection with this reference may be made to Taylor.—*Agricultural Journal of India*, Volume VII, page 23."

***

The Agricultural Journal of the Bihar and Orissa Agricultural Department is issued half-yearly. The number published in October, 1913, contains articles on "The Advantages to be derived from Well-boring" and on "Hilsa-hatching Operations at Monghyr in 1912." as well as several articles on different aspects of the growth and storage of potatoes, and an account of the operations against the Surface Caterpillar on the Mokameh *Tal.*

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The Cultivation of the Coconut Palm in Burma is the subject of Bulletin No. 11 of the Department of Agriculture, Burma—price annas two. The Bulletin contains concise directions for the selection, preparation, planting, and maintenance of a coconut plantation.

***

The chief interest in the *Central Provinces Agricultural and Co-operative Gazette*, for readers outside the Central Provinces, lies in the record in Part II of the continued progress of the Co-operative movement, and in the instructive commentary on the working of Societies contained in the "Registrar's Notes."

The November number of the *Gazette* contained an account of the Second Annual Provincial Co-operative Conference for the Central Provinces and Berar. There were then 1,580 Societies in the Provinces with 30,000 members and a total capital of Rs. 38,00,000. Deposits in the Central Banks had grown from insignificance at the beginning of 1911 to over Rs. 50,000 at the end of last year.

In the face of the widespread and substantial nature of this movement we may feel confident that instances of fraud such as those mentioned by the Registrar in his "Notes" in the March number of the *Gazette*, *e.g.*, the starting of a Society by an influential villager for the purpose of raising a loan for himself on the unlimited security of the members of the Society, will serve only as a salutary warning, to increase the vigilance of the public.

The crystallisation of the amorphous mass of the Indian population around definite points each of which is the focus of a strong public opinion based on a vertebrate experience of men and things, is assuredly not the least of the functions of the Co-operative movement.—(A. C. D.)

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The Indian Agricultural World.—We have received the first copy of the *Indian Agricultural World* edited by Mr. P. A. V. Iyer, Triplicane, Madras; annual subscription Rs. 10. This magazine does not suffer from any lack of reading matter as it totals up to some 100 odd pages, but after reading it through we would offer the following advice in all good faith to its editor. There is undoubtedly room for an agricultural magazine in India (and it is to be hoped that the *Indian Agricultural World* will supply this want) which will present matters agricultural to the public in an interesting form, neither erring on the scientific side to the point of dulness nor on the empirical side to that of inaccuracy; but if the *Indian Agricultural World* wishes to supply this want, it must start off on a line of its own. Let it formulate a definite line of policy and hold definite views. This magazine at present rather lacks original matter and we hope that the Editor will take all necessary steps to remedy this defect in future issues.—(M. W. S.)

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CONTENTS

METHODS OF ECONOMISING WATER USED IN IRRIGATION IN AMERICA.

BY

M. NETHERSOLE, C.S.I.,

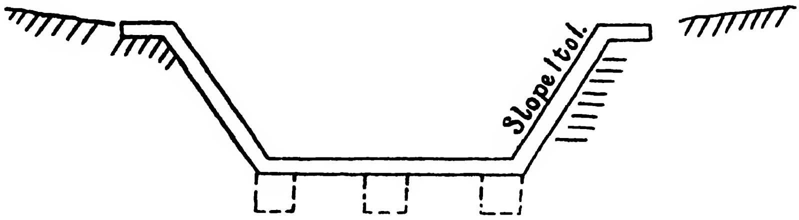
Inspector-General of Irrigation in India.

PUBLIC interest at the National Irrigation Congress, at Pueblo, centred in the partition of supplies as between neighbouring States, and its control by the Federal Government ; with but few exceptions the papers read, and the ensuing discussions, dealt with these political questions, rather than with the technique and practice of irrigation.

In the exhibition there was a good show of the products of local irrigation, and of pictorial advertisement, calculated to attract settlers to the irrigated tracts of the Western States ; and the show of agricultural implements was fair. But irrigation plant was poorly represented ; there were four exhibits of gasoline and electric pumps suitable for small installations ; a mechanical lift of the Persian wheel type, and one or two samples of patent cement piping. There were no demonstrations of economical methods of distribution. Thus, considered either as a field of technical discussion, or as an exhibition of the practical points, the Congress was disappointing though through the courtesy of the Board of Control, and more especially of Dr. Gray, the Foreign Secretary to the Board, the writer was put in touch with several of the leading men, official and private, who were interested in irrigation in all parts of the States, to whom he is indebted for the information contained in this memorandum. It is to be regretted that time did not permit of accepting the many invitations offered for inspecting the different systems.

Lining of Main and Distributing Channels to prevent seepage.—There is a marked advance in America as compared with Indian practice in the lining of channels to prevent losses of percolation. Cement concrete is the lining most generally adopted as in the typical section sketched in Fig. 1.

Fig. 1



The thickness varies from a 1″ plaster skin applied to small water-courses carrying 1 cusec and upwards, to 3″ for a channel carrying about 10 cusecs and upwards, to a 6″ lining for a channel of 700 cusec capacity which is the largest to which such a lining has so far been applied. In the larger sections the bed is fortified by small dwarf walls shown in dotted lines in the sketch.

Other methods employed are timber flumes built of scantlings or planks either of circular section, strapped with iron hoops, or rectangular—these are however generally used only along hill-sides, and in difficult positions ; the tendency being to use the more durable cement-concrete whenever it is possible to do so.

As an example of this wholesale lining of channels, reference may be made to the Beaver Creek Irrigation scheme. The scheme was started two years ago by a private company who bought the tract, together with the water-rights, from the old settlers, who were unable to fully utilize the supply owing to the difficulty of getting the water on to the land. The price paid was from $4 to $5 per acre. The creek supply is estimated to average 40 cusecs with a minimum of 18 cusecs in the summer months ; it was 25 cusecs at the time of inspection. In order to help out the minimum supply two storage reservoirs are included in the scheme—one to contain 3,000 acre feet is very nearly completed, the other to contain 4,000 acre feet is not

yet commenced. The whole of the distributary system is lined, with the exception of one length which is in such good clay that lining was considered unnecessary. The supply channel is partly of circular wooden fluming, 42″ in diameter, and partly of cement-concrete lining. The distributaries south of the main are all of cement piping varying from 2′ 0″ to 8″ in diameter, laid from 2′ 0″ to 8′ 0″ below ground surface. Water is delivered to the land-owners by measurement over weir crests at surface boxes. One such box is provided at or near the corners of each 40 acre plot; so that each 10 acre plot, which is the minimum holding permitted, has easy access to its supply.

The first impression, on inspecting this scheme, was one of surprise that it should be capable of giving an adequate return on the expense of engineering it on the scale described. The explanation lies in the enormous crop values realised on irrigated lands in America. At the Congress it was stated that as much as from $1,000 to $1,500 = Rs. 3,000 to Rs. 4,500 was the gross value per acre of a good fruit crop from irrigated orchards, and even as much as $4,000 = Rs. 12,000 in exceptional cases in the orange orchards in California; values which are impossible in India. The Manager of the Beaver Co., who is an orchard farmer of long experience, stated that he regards $1,700 as a safe estimate of average yield for a well stocked orchard in full bearing. Hence it is not surprising to find that the land is selling readily at from $200 to $300 per acre as soon as water is available; and of the 4,500 acres which is in command of the present scheme with its single reservoir, the company has sold over 3,500 acres, the greater part of which was already stocked with young fruit trees and vines and cropped with lucerne and maize.

The supply is adjusted, on the indents of each owner, by Ditch-riders who report the same by daily cards to the head office in Penrose. As soon as the water supply is secured to each section the company sell the land with the water-right to 1·5 acre feet per year delivered at the surface boxes, no further water rates are charged except for upkeep and regulation which remains in the control of the company; this cost is posted daily, in ledgers which are at all

times open to the inspection of the land-owners, and is periodically distributed *pro rata* on the whole acreage. The cost of upkeep for the present year is estimated at $1·50 per acre, construction being still in progress; it is expected to rise to about $2 per acre when the scheme is complete, and the sale contracts preclude its ever exceeding $3 per acre, the company accepting all liabilities above this limit. There is a Resident General Manager in charge who undertakes the clearance and stocking of the land for non-resident purchasers at cost price—thus the whole system is self-contained and co-operative.

The land-owners are already commencing to line the water-courses leading from the surface boxes with cement, and the Engineer in charge was arranging with one of the Oil Companies for a supply of heavy oil at wholesale rate for treatment of the smaller channels. He hoped to be able to supply it to the land-owners at about 6 cents (3 annas) per gallon. Experiments on the various linings suitable for small water-courses were carried out by the Bureau of Irrigation Investigation in 1907 with results as follows:—

Nature of lining.	Average percolation in inches per hour per 10 days including all evaporation.	Ratio of Efficiency.
Earth Channel no lining	0·355	1·00
„ „ light oil	0·329	1·08
„ „ heavy oil 2½ gallons per yard ..	0·239	1·37
Clay puddle	0·185	1·78
Earth Channel heavy oil 3¾ gallons per yard ..	0·176	2·02
Cement mortar 1 inch	0·121	2·73
„ concrete 3 inches	0·046	7·17

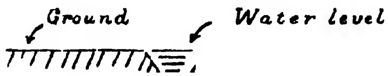
Considerable progress is being made in all parts of the country in the lining of small water-courses, more especially where crop values are high and the water scarce. This is generally done in all pumping schemes.

Methods of field distribution, Surface flooding.—American methods of applying the water to the fields differ considerably from those practised in India. The general use of machinery for cultivation and harvesting renders it inconvenient to sub-divide

the fields into small compartments by means of ridges; hence in America for surface flooding it is the practice to take a great deal of trouble in systematic levelling of the fields so that large areas may be flooded equally without undue waste or damage to the crop in the lower levels. This point was strongly insisted on, as essential to successful and economical irrigation by this method, by more than one practical farmer. It follows that water is generally handled in larger volumes than is the case in India.

Furrow system of irrigation.—Except for rice and small grain crops the tendency in America is to irrigate by the furrow system, explained in the sketch:

Fig. 2



the water being run into a series of furrows by means of a transverse feeder crossing them at a high level. For a field longer than say 330 feet a second transverse feeder is introduced. This method to be successful also requires very careful grading of the field in the direction it is intended to run the furrows. The chief advantage claimed for this method is a diminution of evaporation losses. Experiments conducted by the Irrigation Investigation branch of the Agricultural Department give the following comparative evaporation losses for the same soil for the period June 20th to October 24th:

	Acre feet.
By surface flooding	0·62
,, furrows 3 inches deep ..	0·55
,, ,, 12 inches deep	0·41

This practice appears to have originated in the irrigation of fruit orchards, large furrows being run down each side of the tree rows; but it has quickly extended to any crop which is planted in rows sufficiently far apart to admit of the furrows (made

of course by a furrowing machine of which there are several patterns) being run between them without injury to the crop. One farmer near Denver said he was intending next season to apply it experimentally to wheat, spacing the rows 10″ apart for the purpose.

Retention of moisture in the soil.—American practice is extending largely in the direction of "cultivation" after each watering, whenever the crop is of a nature or of a size to admit of the "cultivator" being worked—this is in order to break up the caked surface which follows flooding, and to maintain a top layer of finely divided soil known as a "mulch" in American parlance. This "mulch" is very effective in retaining the moisture in the lower soil by checking evaporation as is proved by exhaustive experiments carried out by the Irrigation Investigation Bureau, the results of which are given in the following table abstracted from the *Agricultural Year Book* of 1908 :—

Period of test.	No mulch.	3″ mulch.	6″ mulch.	9″ mulch.
1st test 21 days, June 10th to July 1st ..	21·92	5·16	2·06	0·52
2nd test 32 days, September 1st to October 3rd	34·59	14·71	5·93	0·78

The figures represent the percentages of the water applied in 6″ waterings lost by evaporation during the two periods.

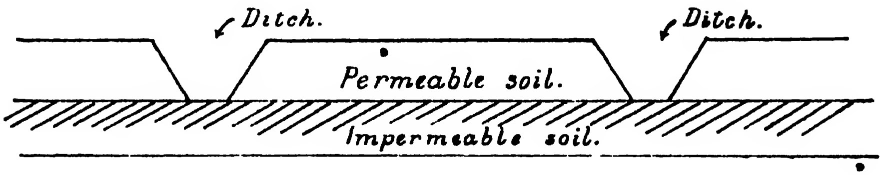
The experiments have led to the development of two new methods of applying water to the crops known respectively as "Winter Irrigation" and as "Sub-Irrigation."

"Winter Irrigation" consists in breaking up the subsoil by a machine which loosens without turning it to a depth of about 18,″ thereby increasing its capacity for holding water—then thoroughly soaking the land by surface flowing at a time when the water is otherwise not required for irrigation and, as soon as the surface is dry enough, ploughing and working up the top 6″ into the desired "mulch." Farmers who have tried it say that they are maturing better crops by this method with a very appreciable saving in the total water used—the crops requiring but one or two other waterings instead of the 4 or 5 formerly necessary without winter irrigation.

The same principles underlie the system of improved "Dry Farming," as it is called, which aims at conserving the rainfall by rendering the soil more readily receptive of the rain as it falls and by subsequently checking its evaporation.

"Sub-Irrigation" aims at supplying a sufficiency of water to the crop roots without any disturbance of the surface soil. In its initiation it was employed for orchard irrigation only but recently it is being developed for general crops. In a few cases where physical conditions are favourable this system is applied by seepage from ditches run at suitable intervals transverse to the general slope of the ground ; the essential conditions are a moderate depth of light permeable soil over harder and more impermeable strata.

Fig. 3.



The lower ditch acts as a drain to prevent undue water-logging and the system is kept running so long as the crop shows no signs of getting too much water.

There are several tracts in California where this method is employed with marked success and with great economy of water depths per acre. This is however exceptional and clearly dependent on the required physical condition ; the more usual method of "Sub-Irrigation" is by means of pipes. The first pipes used were ordinary drain pipes laid from 1 foot 6 inches to 2 feet below ground surface with open joints through which the water percolated into the soil, and at first the system was applied to orchards, one line of pipes being run along each line of trees. It was found however necessary to give a pipe line along each side of each row as otherwise the roots were attracted to the pipe line and the tree growth became irregular. It was also found that the roots made their way into the pipes through the open joints, blocking the pipes. This defect has been

met by several forms of patent pipes, such as of honeycombed concrete permeable to water but said to be impermeable for the roots. These appear to be made by restricting the cement matrix so that it will not fill completely all the spaces in the ballast or gravel. Another method is to give small upright pipes perforated and accessible from the top at each tree, so that they can be kept clear of roots, the pipes between the manholes having cemented joints. The success and economy of water applied by this method in orchard irrigation has led to experiments with the same system for general farming. The water is fed from a main pipe under pressure into branch pipes or laterals, spaced from 30 feet to 100 feet apart depending on the soil; each lateral is under complete control by means of a valve at its point of departure from the main pipe.

The Wiggins system is the most recent development, and is now being demonstrated at Garden City, Kansas. The writer was told by two or three farmers who had seen the system working during the last season that the crops raised were excellent and very even in quality, showing no difference along the pipe line. The Irrigation Investigation Officers, however, are doubtful whether the spacing of the pipes at such wide intervals as even 30 feet apart will prove effective for general crops, and while admitting that the Garden City experiment is on a thoroughly practical scale and has been successful this year, they state that it was favoured with exceptionally good growing weather and helped out by timely rain; they therefore do not consider this year's test conclusive as to the general efficiency of the system as applied to general farming in ordinary or dry years.

Pumping.—As already noted, the exhibits of irrigation plant at the Congress were very limited, and it was impossible to gather from them any new information of value. It appears that many of the artesian supplies near Denver, which ran freely when first tapped, have since become so reduced as to require the application of mechanical pumping.

There are several large and successful pumping installations in different parts of the States, but so far as could be ascertained

from enquiry. the water bearing strata are either gravel or coarse sand. No improved methods of pumping from a water table in fine sand subsoil, a solution of which problem is of such prime importance to India, could be learnt. Gasoline driven pumps appear to be more generally adopted than any other form, owing to the small amount of supervision they require and to the readiness with which they are started.

THE CULTIVATION OF RICE IN SPAIN AND THE RECENT INTERNATIONAL RICE CONGRESS AT VALENCIA.

BY

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RICE CULTIVATION IN SPAIN.

AMONGST the rice-growing countries of Europe, Spain occupies the second place, with 96,000 acres devoted to the crop, against 360,000 in Italy. In the other southern countries the amount grown is insignificant; Bulgaria has commenced the cultivation, the new provinces of Greece contain two or three thousand acres, and there are some hundreds in the Rhone Delta in France, where an effort is being made to popularise the crop. One of the chief difficulties in the way of an extension of the area is the prejudice which exists against rice growing in populous tracts, owing to the danger of inducing malaria; and one of the most interesting discussions at the recent Congress arose from an attempt to show that this prejudice is unfounded, provided that certain precautions are observed. If this view gains credence, it can hardly be doubted that there will be a material increase in the European production of this cereal.

The cultivation of rice in Spain is limited to the East coast, and nearly three-quarters of the area is situated in the province of Valencia. The greater part of this is permanent rice land, unlike what exists in Italy and Greece where rice is grown in rotation with other crops. In this, and as will be evident later on, in many other particulars, the cultivation in Spain approximates more closely to that of India than elsewhere in Europe.

The rice-growing district of Valencia is a plain between the mountains and the sea. The slope is gentle, and towards the sea

Fig. 1. PUDDLING THE SEED BED

Fig. 2.—PUDDLING WITH THE "DRAGA".

the land is almost level, of slight elevation, and naturally marshy. At one place it is broken by the large lake, or more strictly speaking lagoon, of Albufera, whose shores are ill-defined and merge into a plain of rice fields recalling the swamp rice lands of the lower delta of the Ganges and Brahmaputra in Eastern Bengal.

The whole of this area is supplied by a magnificent system of irrigation canals derived chiefly from the rivers Jucar and Turia. Though irrigation was apparently practised in the time of the Romans, its full possibilities were not achieved until the Moorish conquest, and it is to the Moors also that the introduction of rice cultivation is due. It is highly probable that many of the distinctively oriental practices followed, and in particular that of transplanting, unknown elsewhere in Europe, are to be traced to the prolonged occupation of this district by an Eastern people.

Since the cultivation of rice in Valencia has been probably brought to a higher pitch of perfection than anywhere else in the world, a brief description of the methods followed, as far as it was possible to ascertain them in the time available, should be of interest.

The seed beds are placed in higher land than the final rice fields, as in India, and are frequently many miles away from the latter. The district of Alberique, near the head waters of the irrigation system of the Jucar, is reputed especially suitable for growing seedlings, which are exported freely to the lower districts towards the sea. Their preparation offers nothing special, except that they are frequently green-manured or receive a heavy dressing of mineral fertilisers similar to that applied to the main fields. They are puddled before sowing in order to render the sub-soil impermeable. This is done by driving horses up and down, with or without the use of harrows (see Plate XXIX, Fig. 1).

The main rice fields are still covered with water at the time of harvest in September-October and are left to dry out gradually. They receive a working in the mud or while covered with a shallow layer of water in January or later, according to the district. This is done with harrows, derived from the Acmé and disc harrows (several forms are in use), specially calculated to cut up and bury a weed which is one of the chief troubles of rice cultivation in Spain,

Leersia Oryzoides L. In order to render the lower lands, where the soil is a heavy tenacious clay, more easily worked after drying, a special harrow, the "rallaora," has been introduced, which is run through while the land is still moist. It consists of large discs over a foot in diameter and set about a foot apart, which simply make vertical cuts in the soft soil; the draft is said to be exceedingly light.

The fields are now dried out completely and when dry receive the most important working of the year, a thorough ploughing

FIG. (*a*).—CHARUGA.

with heavy draft inverting ploughs. Modified Lincoln ploughs ["charuga" Fig. (*a*)] were formerly and are still extensively used for this purpose but are now being replaced by double Brabant ploughs, which require two or three horses to draw them [Fig. (*b*)]. It is not so long ago that the "forcat" [Fig (*c*, p. 330)], which recalls the native Indian plough, was in general use, and the cultivators of Valencia consider the introduction of inverting ploughs one of the greatest advances that has been made in their hereditary occupation. Its effects have been far-reaching, and an interesting paper was presented to the Congress describing the modification in the local breeds of horses caused by the need of a more powerful animal than the Andalusian horse to draw these ploughs and met by the import of Breton mares and colts; nearly two-thirds of the horses of Valencia are now of French or mixed origin.

The object aimed at in this ploughing is to leave the soil exposed to the action of the atmosphere in large masses and to dry it to as great a depth as possible. Nevertheless, in the heavy lands near

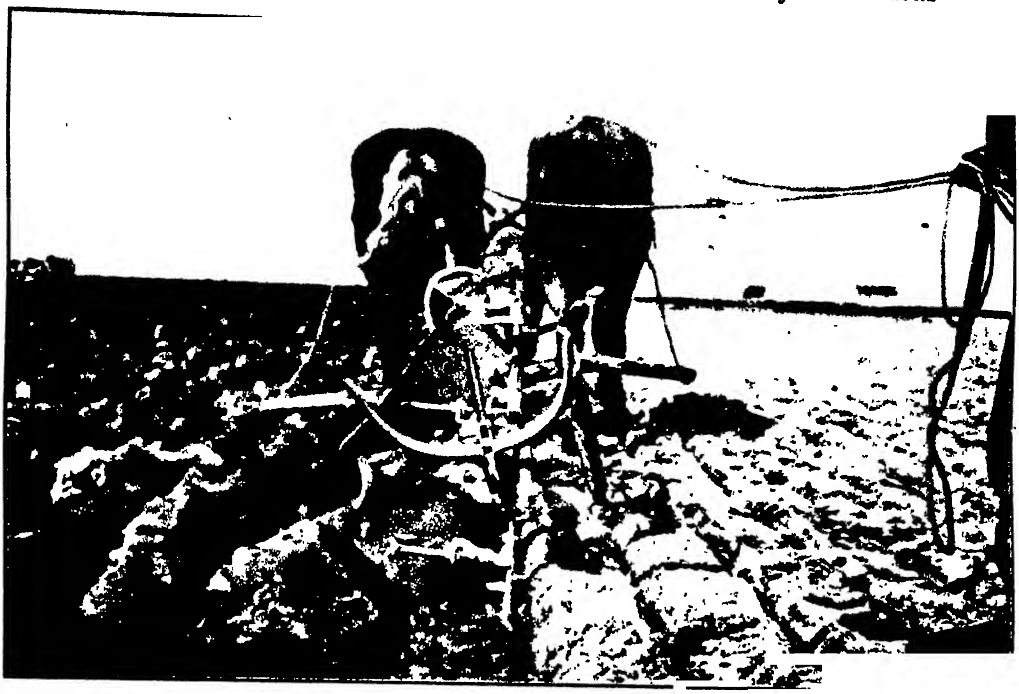

FIG. 96.—DOUBLE BRABANT PLOUGH.

Albufera, a depth of 5 or 6 inches is not usually exceeded. The use, in these lands, of the "rallaora," the cracks caused by which are said to expand as the soil dries out in the early months of the year, serves the double purpose of deeper aeration and of making the work of the heavy plough easier when the time comes for its use. It will be seen that the question whether cold weather cultivation is advantageous or not in swamp rice culture, a debated one in India, has been decided in the affirmative in Spain. There is even talk of introducing steam or motor traction to reduce its difficulties and expense and to render it more thorough.

In May, a few days before the time for transplanting arrives, the water is run in again and a final puddling given which destroys any further growth of *Leersia Oryzoides* and reduces the permeabi-

lity of the soil. The "draga" or modified Acmé harrow is used for this (see Plate XXIX, Fig. 2), but a better implement for the purpose is stated to be the Sargenti harrow, also derived from the Acmé and highly spoken of in Italy.

FIG. (c).—FORCAT.

The fields are very heavily manured. Leaving out green-manuring, which is chiefly practised in the higher lands as in the Alberique district, it is customary to give heavy dressings of sulphate of ammonia and superphosphate * and many add a potash manure. A common mixture is sulphate of ammonia 40 per cent., superphosphate 54 per cent., and sulphate of potash 6 per cent., and this is used at the rate of 600 to 800 lbs. per acre. The time of application varies but usually half or three-quarters is applied a day or two before admitting the water prior to transplanting and the rest three or four weeks later, the water being run off for the purpose; sometimes, however, all is applied before transplanting. In Alberique guano is said to be largely used at about the same rate. Cyanamide is at present being vigorously boomed. It is of interest to note that nitrates of potash and soda are said to be entirely unsatisfactory, an

* The soils of this region are deficient in phosphoric acid, which is rarely found in the proportion of 1 per 1000.

experience which is in harmony with recent views regarding the form in which nitrogen is assimilated by rice. The opinion was expressed that the use of sulphate of ammonia has been carried to excess, and in the first report (for the year 1913) of the Experimental Rice Station of Sueca (near Valencia), the Director, Señor E. G. Montesoro, gives strong support to this view as a result of a carefully devised series of experiments. In the same report doubt is thrown on the necessity for adding a potash manure to the rice lands of Valencia, and there was a lively discussion on the subject in the Congress, the balance of opinion being against potash manuring.

Experiments have been carried out at Valencia for several years to test the action of manganese, which has been found in Japan to augment considerably the yield of rice. The results are in contradiction with those obtained in Japan, but as a little manganese is already present in the local soils it is not denied that beneficial results may be obtained where this element is entirely deficient. Further, Dr. H. C. Oria, Professor of Organic Chemistry at the University of Valencia, presented a paper in which he suggested that the beneficial action of manganese is to be traced to its rôle as a catalyser, resulting in the better oxygenation of the roots, and that for this to be fully exercised certain requirements must be fulfilled. These are that the manganese should be in the form of carbonate, either added as such or formed by reaction with potassium carbonate and that there should be organic acids in sufficient quantity in the soil to decompose the carbonate and form organic salts of manganese of high molecular weight. He attributes the contradictory results in Japan, Italy, and Spain to failure to observe these conditions uniformly.

Transplanting is done in a few inches (3 to 5) of water. The seedlings, after being taken from the seed bed, have the soil very completely washed from the roots and are put up in bundles of 4-500 plants for transport to the fields. A delay of 24 hours in transport does not seem to be thought excessive. The relation of seed bed to field in area is 1 to 10 or 12, and about 250 bundles are used per acre. The transplanters work backwards, and every movement of the operation is exactly as in India (see Plate XXX, Fig. 3).

Each clump contains 3-5 plants (single seedling transplanting appears to be unheard of) and the distance between the clumps is 8 to 10 inches. Six men will transplant a hectare (2·47 acres) in a day and they were being paid this May 5 to 6 pesetas (3/10 to 4/7) a day.

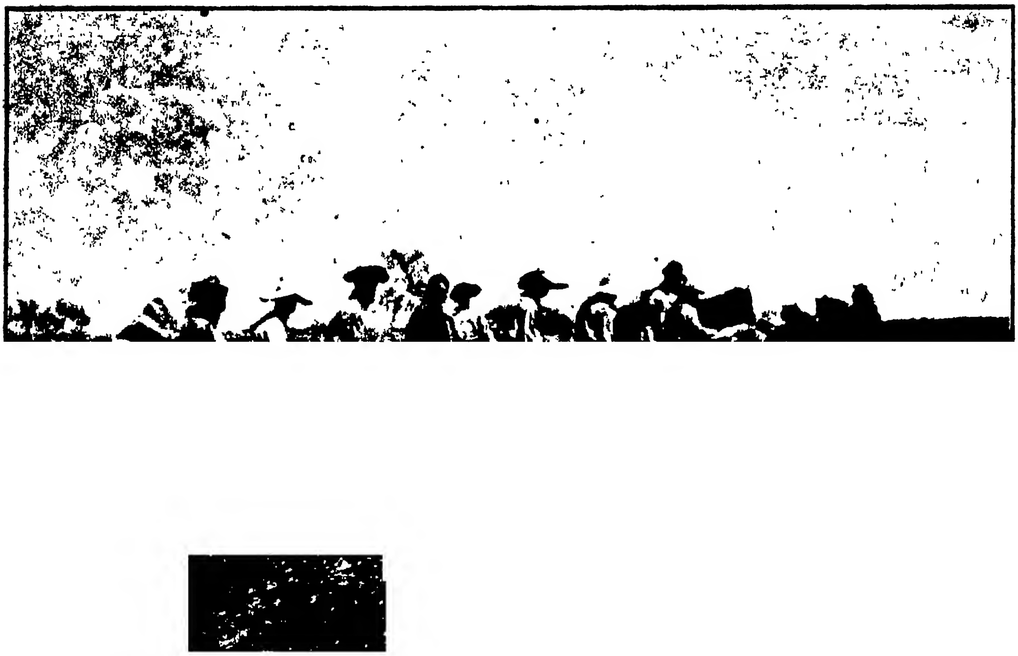

FIG. (*d*).—TREADING OUT THE GRAIN.

As in India the crop requires little attention during its growth period. The chief operation is the *aixugo* or running off the water in June, when the fields are weeded and a part of the manure is frequently added. Harvesting is done with the sickle, and the grain is still usually trodden out by horses and the feet of the labourers who are armed with wooden forks for turning over the straw [Fig. (*d*)]. It is freed from the chaff by throwing into the air, sufficient wind for the purpose being rarely wanting at the time [Fig. (*e*)]. Winnowers are little used. Of late threshers have come in and there are now many of all sizes and of special types suitable only for rice. The large installations have reduced the cost of threshing by nearly half. They are driven by steam, elec-

Fig. 3.--TRANSPLANTING RICE IN SPAIN.

Fig. 4.--VIEW AT HARVEST.

tricity, or gas, and are said to be thoroughly satisfactory.* The further preparation for the market is carried out in modern mills equipped with machinery which is much the same as that in use elsewhere, rice milling machinery being now of a practically universal type. Polishing is practised on a comparatively small scale only.

FIG. (e).—CLEANING THE CHAFF.

The following table gives the yield of rice in Spain in 1913, as compared with that of other countries †:—

Country.	Area under rice in acres.	Production in tons.	Yield per acre in lbs.
Spain ..	96,000	246,000	5,700
Italy ..	360,000	534,000	3,300
Egypt	254,000	375,000	3,300
Japan	7,393,000	7,026,000	2,100
United States	827,000	517,000	1,400
India	70,580,000	28,167,000	800 (This must be a rough average only. There are many districts in Bengal and Madras where the yield is double.)

* The chief makers are Domingo Gomez Fils of Valencia.
† The figures supplied to the Congress were quoted from the *Bulletin of Agricultural Statistics of the International Institute of Agriculture*, Rome, March, 1914.

From the above it will be seen that the average yield per acre in Spain *is almost double that* obtained in Italy and more than six times the Government figures for India. The excess over Italy is partly to be traced to the practice of transplanting, universal in Spain and unknown in Italy; over India to heavy manuring, better cultivation by means of specially suitable implements and, to a less extent, better varieties.

The study of varieties of rice was the first subject discussed at the recent Congress. It has not been taken up seriously in Spain until very recently but its importance seems now to be fully recognised. In Italy it has been energetically carried on at the Station for Rice Cultivation at Vercelli and elsewhere, during recent years, with remarkable results. Both Italian and Spanish authorities appear to be agreed that the continued cultivation of a variety without selection in the same locality leads to degeneration and the appearance of the destructive disease known as *brusone* and that one of the most important factors in successful rice cultivation is the succession of new varieties obtained by importation and selection. Accordingly one of the chief subjects taken up at the newly established Rice Station at Sueca (Valencia) is the study of varieties, both imported and indigenous. Having in view the remarkable success obtained in Italy with varieties of Japanese origin, a number of these have been imported and several give promise of being suitable for cultivation in Spain. Little attention appears to have been paid as yet to Indian varieties in Europe.

In resuming this short account of the highly perfected cultivation of rice in Spain, three things seem particularly calculated to arrest attention: The universally accepted importance of a thorough cold weather cultivation of the fields, rendered possible by the use of specially adapted implements*; the necessity for employing considerable quantities of suitable nitrogenous and phosphatic manures; and the value of introducing exotic varieties with a view

* The Station for Rice culture at Vercelli (Novara), Italy, has in preparation a detailed account of the results of a very complete series of experiments with all the implements suitable for rice cultivation that they have been able to get together, with data of construction, draft and efficiency, and the volume should be essential for any one requiring fuller information on this subject.

to checking deterioration of races long cultivated in the same environment. All these appear worthy of more detailed consideration than they have received in India, though the first two present difficulties in the way of their introduction on any large scale under present economic conditions, and particularly the second in view of the inferior draft animals available in the greater part of the rice-growing tracts of India. But the results in Spain have been obtained on a system of cultivation which, unlike that elsewhere in Europe, is fundamentally the same as in India, and we have no such difficulties to face as confront the Italians, for instance, in the attempt they are making to introduce transplantation.

The 5th International Rice Congress.

The subjects set down for discussion were arranged under eight heads, each of which was assigned in advance to a special local committee, with a view to preparing notes to serve as a basis for discussion. Each of these heads was then submitted to a Section of the Congress, but as the Sectional meetings were arranged so as not to clash, they became, in practice, meetings of the full Congress.

The conclusions were drawn up in a series of resolutions which were submitted for formal acceptance at the final session of the Congress. The proceedings lasted a full week, from the 17th to the 24th May, 1914. Excursions were arranged to the chief centres of rice cultivation in the neighbourhood, and also a visit to an up-to-date rice mill. No effort was spared by the local executive committee, the organising genius of whose President, the Count de Montornés, was much in evidence during the week, to make the meeting a success. Like most assemblies of the kind, the formal sessions were of less value than the opportunity afforded to the delegates of learning something of the actual agriculture of the country and of discussing their problems together outside the Congress. As was fitting, in view of the lead which Italy has taken in the scientific and practical study of rice cultivation, the Italian delegation was the most important, both in numbers and authority,

and included several members of the staff of the well-known Station for Rice Culture at Vercelli, headed by their Director, Signor Novello Novelli. Other countries represented were England, France, Greece, Portugal, the Argentine, China, Colombia, Guatemala, Indo-China, and Venezuela. It is impossible to avoid referring to the extraordinary cordiality of the reception offered to the members of the Congress by the various public bodies of Valencia and by the people as a whole.

The first subject taken up was the study of varieties of rice, their importation, and the preservation of their characters by selection. In the note presented as a basis for discussion, stress was laid on the unsatisfactory nature of the classifications available of the varieties cultivated in Europe, both from the agricultural and the scientific point of view. It was pointed out that the same variety was known by several different names according to the locality in which it was grown, and that the constant multiplication of so-called varieties had led to the greatest confusion. Accordingly it was suggested that the first step necessary was the formation of a true botanical classification of the varieties of rice under cultivation. This suggestion clearly did not take into account the enormous difficulties of the task imposed, and several speakers insisted on the fact that a true botanical classification of rice, which would deal in a satisfactory manner with all the varieties cultivated in various parts of the world, was not yet possible. The classifications made by Kikawa in Japan and Graham in the Central Provinces in India were referred to as indicating the immense number of varieties which would have to be included, and the difficulty of deciding on characters which would stand the test of preserving their uniformity under different conditions of the environment. The following resolution was finally adopted:—
"That the botanical study of the varieties of rice cultivated should be taken up in all countries, and that each should make a provisional classification founded on characters which might be considered as fixed; as soon as some of these characters have been established, they should be communicated reciprocally between the institutions which, in each country, are charged

with this study, in order to arrive at a unification of method."

In dealing with the importation of varieties no hesitation was shown in advancing the proposition that this was of supreme value in checking deterioration of the crop. The present writer is not aware that the subject has ever been regarded in this light in the East; certainly it has not been seriously considered in India. But Italian experience has led to the definite acceptance in Europe of the view that rice long cultivated in the same locality degenerates, and that it is necessary to import and acclimatise new varieties and to preserve their vigour by local selection, and the exchange of seed between fields which differ in soil, water, and other environmental conditions. In other words, the experience which has been pretty well universal with regard to crops which are propagated vegetatively, such as sugarcane and potato, is held to apply to rice also, though propagated by seed. In importing varieties it was advocated that care should be taken to select sorts likely to be really adapted to the locality through having been grown under similar conditions in the country of origin. This is an aspect the importance of which seems liable to exaggeration; naturally one would not import Indian deep-water rices for trial in the higher lands at Alberique; but to insist, as the note presented to the Congress did, on the necessity of having with each variety an analysis of the soil in which it was grown and of the irrigation water, with details of the quantity and composition of manure employed, the methods of cultivation, the prevailing winds and their maximum and minimum velocity, and so on, is certainly to go beyond reasonable requirements. The resolution on this subject "That the exchange of seed should be made by official centres in the different rice-growing countries, the samples being always accompanied by a history of the variety," is, however, sufficiently indefinite to allow of free interpretation.

The selection of seed is little understood and less practised in Valencia. It is, for instance, startling to read in one of the papers presented to the Congress that "Providence has assigned to all plants a certain limit of production, and when man, pushed

by his boundless ambition, forces them to overstep the limits which natural law has imposed on them, their degeneration is immediate and their death near." Little of value emerged from this part of the discussion and the resolution "That every country should adopt the same method of selecting seed" is not likely to commend itself just yet to the botanists engaged in the study of rice.

The second Section dealt with the methods of assimilation of fertilising substances by rice and the most modern methods of manuring this crop. An interesting paper was read by Siñor E. Herrero, recording the results of experiments to determine the rate at which the chief elements are absorbed, and the relative requirements at different periods of development of the crop. The results obtained showed that 72 per cent. of the dry matter was formed between the time of transplanting and the completion of vegetative growth, a period of 52 days. In this period the absorption of nitrogen kept pace with the increase in the dry matter, the absorption of phosphoric acid was proportionally more rapid, and that of potash was intermediate. From completion of growth to the formation of the ear, a period of 22 days, the nitrogen still kept fairly parallel to the dry weight but the potash diverged widely, reaching its maximum of absorption in this period; the phosphoric acid absorbed also, considerably exceeded its proportionate quantity. In the period, also of 22 days, from the formation of the ear to ripeness, the nitrogen continued to be absorbed at a rate parallel to the increase in the dry weight, but the potash fell away greatly; the absorption of phosphoric acid continued to increase, but at a less rapid rate now than the dry weight. As the absorption takes place by the roots, the relative proportion of roots to above-ground parts at different periods is of importance in considering the amount of assimilation they can perform, and the consequent need of providing the elements in a readily taken up form. The examination of this factor showed that the roots being relatively less toward the end of development, while the absorption of nitrogen continues to keep pace with the increase in dry matter, each unit of assimilating root-area is called on to provide nitrogen at a more rapid rate in the last period of development than earlier. Hence there

seems to be a need of supplying nitrogen in a readily available form at this period. This does not apply so much to phosphoric acid, the absorption of which slackens at the end; and not at all to potash, which ceases to be absorbed after the formation of the ear.

In the discussion much time was occupied in the advocacy of the use of potash and cyanamide by the representatives of these industries, and in the case of the latter a good deal of evidence was offered to prove its value for rice. A resolution was finally adopted that "the Congress while applauding the interesting study made by Señor Herrero on the assimilation of fertilising elements by rice, which is of remarkable interest in the technique of manuring rice, expresses the wish that such studies should be continued and completed in regard to the kind of manure which is suitable, as well as the best periods for its application; and that also the scientific study of the action which different manures exert on the rice fields, both as to their utilisation and profitableness, should be taken up."

In the third Section, the subject considered was the operations of cultivation, of harvest, and of elaboration, and the machines most suitable for perfecting these operations and reducing their cost, especially in small holdings. An exceedingly interesting and lucid note was presented by Señor E. L. Guardiola, one of the General Secretaries of the Executive Committee, giving an account of the implements and machines in use in Spain, and of some foreign ones worthy of trial. This was supplemented by Prof. Tarchetti, one of the leading authorities in Italy on this subject, who described the advances made in that country in recent years, which appear to be very striking. It was surprising to learn that the number of machines specially devised for the different operations in the cultivation and harvesting of rice runs into dozens, but as their description is unintelligible without diagrams, it is necessary to await the promised volume referred to in the foot-note on p. 335 for fuller information. The importance of the subject was felt to be such that the Congress adopted the following resolutions: "(1) It would be advisable to publish, from an international standpoint, a Review to be the official organ of the different stations for rice

culture in the world, which would describe the methods employed in each country, and would deal in particular with the study and wide diffusion of machines calculated to perfect the cultivation of rice both in small holdings and on a large scale, while reducing the cost. The International Institute of Agriculture would perfectly fulfil this mission. (2) From the point of view of cultivation in Spain competitions of motor ploughs, as well as of dryers and harvesters, specially suitable for rice, should be organised."

Another Section was occupied in considering a subject arising out of the last, namely, the influence which has been exercised on the equine population of Valencia by the improvement in the methods of cultivation of rice. The facts of the case were set out in a very full note by Señor R. J. Janini, who showed that between 1861 and 1891 the Andalusian breed, which was formerly found in the agricultural districts of Valencia, was in great part replaced by French horses, and that this has continued, until now, nearly two-thirds of the local horses are French, which are imported at the rate of about 1,500 a year, chiefly from Brittany. The Spanish horse is too light for the heavy work now required in the rice fields. It was suggested that Spain had lagged behind the northern countries of Europe, especially France and England, in the improvement of horse breeding, though starting with probably better breeds than were available in these countries, and that this industry, so important for the agriculture of the country, was worthy of every encouragement. The following resolution was approved :—"The Fifth International Rice Congress respectfully prays the General Association of Stock Breeders of the Kingdom to examine the lines on which horse breeding should be undertaken in order to stimulate vigorously the production in the Eastern provinces of Spain of breeds suitable for agriculture and for the army."

The fifth Section discussed recent work on the diseases of rice. The most destructive of these is the condition known as *brusone* in Italy or *faille* in Spain, which in some years causes very great losses. It appears to occur throughout the world wherever rice is grown, having been signalled in the United Sates, Japan, Java, and India. At the same time, it is probable that a number of

distinct affections have been confused under the same name and even in Italy, where it has been under observation for many years, different authors are by no means in agreement on its symptoms. In India the problem is being approached in the first instance, by separating out from the conditions which lead to failure of the grain to reach maturity, those which can be definitely traced to the attack of parasitic organisms such as fungi. Some of these have certainly in the past been confused with true *brusone*, and their study is a necessary preliminary to the more accurate limitation of the disease. It appears probable that when all these parasitic diseases have been defined, there will still remain a considerable residue in which the failure of the crop cannot be attributed to the action of any parasitic organism. It is to this alone that the term *brusone* should be applied.

In the discussion, general agreement was shown in considering *brusone* as a physiological degeneration hastened by the action of ill-defined external conditions, climatological as well as cultural. It is interesting to note that in Spain the prevalence of West winds is considered to predispose to *faille:* in India the same is said of South winds in certain localities. Other predisposing causes mentioned were deficiency of oxygen in the water, impoverishment of the soil, and abrupt variations of temperature at certain periods. As a means of reducing the losses caused by *brusone* in Italy, the introduction of exotic varieties of rice was tried some years ago. Success was obtained very quickly and further work in this direction was energetically taken up at the Vercelli station and elsewhere. The Director of the last named institution now considers that by this means a satisfactory method of fighting the disease has been found. Where the new varieties (chiefly of Japanese origin) have been introduced and where, in addition, care is taken not to grow any one variety too long in the same fields and under the same conditions, *brusone* has lost its terrors. Whether this supports the Italian view that *brusone* is a "physiological" condition and not a definite disease is doubtful. Very similar experiences have been met with in the red rot of sugarcane, which is nevertheless certainly caused by a fungus. All that it seems safe to admit at

present is that none of the various parasites to which the disease has been attributed can be accepted as the true cause; it is clear that there is still a vast field of work to be covered before this can be elucidated; but it is equally clear that the Italian methods of combating the disease are worthy of imitation in India and elsewhere that it occurs.

The Congress adopted the following resolutions in this Section:—"(1) It is absolutely indispensable to nominate an International Commission to draw up the plan to be followed in order to determine the factors which are concerned in the phenomenon of *faille* or *brusone* of rice. This Commission may adopt the following limits: (*a*) nature of the soil in which the experiments are made; (*b*) comparative study of the systems of irrigation employed, the depth of the layer of water and its composition, abrupt changes of temperature and mean temperature during the different phases of vegetation, rapidity of flow of the water, etc.; (*c*) manures employed, their composition, quantity, etc.; (*d*) study and selection of the seed used for the experiments; (*e*) experiments with radioactive fertilisers and "thorianisation" of a part of the seed used; (*f*) comparative study of the resistance to certain diseases of each variety of rice under similar conditions. (2) It is necessary to catalogue the species of the animal and vegetable kingdoms, especially insects and cryptogams, injurious to rice; it is equally necessary to protect effectively the birds not recognised as injurious to agriculture, seeking to convince cultivators and the country in general of the necessity for this protection in order to combat the numerous insects which damage all kinds of crops. (3) The various stations for rice culture and for vegetable pathology should carry on experiments with a view to prevent or to combat the animal and vegetable species which cause disease in rice. (4) It is advisable to establish in each rice-producing zone a meteorological station charged with the study of the influence of different meteorological phenomena on the development of certain diseases of rice."

To the sixth Section was assigned the consideration of the world's commerce in rice, and the advantage of international regulation to guarantee the authenticity of marks and origins of the

produce on the market. The note presented described the objects for which rice is employed, the manner in which it is prepared for the market, the variations in price due not only to the quantity produced but still more to the competition of other food grains, the disadvantage under which rice labours in not being considered an article of necessity but a luxury and, therefore, in being exposed to heavier duties and taxes in many countries than other cereals and the difficulty in preventing fraud in the use of marks and indications of the locality from which the produce has come. Amongst the points of interest to India which arose was the active propaganda which is being carried on to popularise the use of rice in districts where it is considered a luxury and is unknown to the poorer classes. This is the case even in Spain where a considerable part of the local produce is exported. Another was the effort which is being made to reduce the cost of internal transport, which is at present so heavy that Indian rice can be delivered in certain parts of Spain at a lower price than that grown in the country itself. The heavy tariffs in force in some countries were also attacked, as presenting a serious bar to the general use of the grain. In France the produce of the French colonies (chiefly Indo-China and Madagascar) is admitted free, while that of other countries is taxed. Most other countries in Europe tax rice more heavily than other cereals.

The following resolutions were passed :—"(1) To carry on a very active propaganda to make known the usages and the applications of rice by means of conferences, the distribution of illustrated pamphlets, samples, and recipes for its preparation. (2) To endeavour to reduce the price of rice by perfecting the cultivation and employing the best and most productive varieties. (3) To perfect the preparation and complete utilisation of the residues so as to diminish the market price, while at the same time seeking to avoid an increase in this price due to the intervention of many middlemen between the producer and the consumer. (4) To secure rebates or suppression of the internal duties which press heavily on rice and the recognition of this aliment as a necessity comparable to wheat and other cereals. (5) To secure reduction of transport tariffs in order to facilitate access to markets whether

internal or foreign. (6) To secure concerted action by Consular bodies, Chambers of Commerce, and other similar bodies, by the agency of an International Convention, to prevent the improper use of names or marks or their falsification and to assure the authenticity of the origin by means of irrefutable documents. (7) To secure a concerted understanding between all the States which produce rice, with a view to establish between them effective legislation and international action against the improper and fraudulent use of marks as well as of all that might mislead the consumer in regard to the origin of the produce, above all requiring that the latter be supported by credible documents.

In the seventh Section there was a very lively discussion on the subject of Co-operative Societies of Production and Consumption as applied to rice. In the former category was included co-operation to assist in the supply of choice seed, in procuring manures and implements, and in furnishing advice regarding sowing, manuring, cultivation, irrigation, and the prevention of disease. In the latter, societies which encourage and facilitate transactions of sale and secure the export of the produce to the chief centres of consumption. It was suggested in the note submitted for discussion that the Societies of Production, of which there should be one in each distinct tract, should maintain an experiment station for the introduction and testing of new varieties, selection of seed, analyses of manures, trial of implements and so on, in addition to their other functions. The Societies of Sale should handle all the rice produced by the members, have it graded by experts, and effect its sale without the intervention of middlemen. In the discussion, considerable opposition to the formation of Societies of the latter category was encountered and the supporters failed to secure unanimity. The final resolution adopted was that, "It is advisable to found Co-operative Rice Societies of production by zones, whose boundaries should mark the differentiation of essential agricultural characters. These Co-operative Societies should federate to form large unions for the protection of their general interests, for the organisation of sale in the country of production, and for export to centres of consumption."

The last subject discussed was paludism and the cultivation of rice. An exceedingly interesting paper was presented for discussion by Señor I. G. Colmenares, Regional Health Inspector, on behalf of the local committee. This commenced by a criticism of the restrictive legislation in force in Spain in regard to rice cultivation, the foundations of which date from 1862 and were naturally based on the views regarding malaria then current. The chief clauses prescribe that the land should be marshy and unfit for any other kind of cultivation, without woods or forests or obstacles to the free circulation of the wind, that it should be at least 1,500 metres from any inhabited spot, that it should command sufficient water for irrigation, and that the drainage should not interfere with neighbouring properties, for which purpose the construction of a canal or ditch around the land is imposed. These provisions were natural enough when malaria was believed to be caused by the miasma or effluvium from stagnant water diffused into the air and capable of acting at a certain distance. They aimed at keeping the rice fields away from dwellings, and at dispersing the effluvium by the wind.

The author of the note drew a distinction between the forms of paludism special to localities naturally marshy, abandoned and without cultivation, where alone the grave æstivo-autumnal type of fever is found, at least in Spain, and the milder form, distinct both clinically and pathologically, found in cultivated localities. When cultivation is being introduced into marshy land the two forms are often found together, and it can be readily understood that the immigrant population are inclined to attribute both to the cultivation. Rice cultivation has naturally been pursued largely in swamp and delta lands, already subject to the graver type of paludism. The incidence of æstivo-autumnal fever amongst rice cultivators was therefore heavy in the earlier days of the spread of the crop, and the prejudice thus caused has interfered with the recognition of the fact, familiar to medical men, that the ultimate effect of this cultivation has been the amelioration of large areas in so far as this type of malaria is concerned. Under such circumstances the cultivation of rice becomes a valuable method of

sanitary improvement, and instead of being restricted should be encouraged by the State.

The conditions under which rice cultivation is hygienically safe were next considered briefly. It was stated that the rice-fields themselves, when suitably established, served only exceptionally as breeding places for anopheline mosquitoes, but that these occur freely in the canals and ditches, where the water is allowed to stagnate, and weeds and debris accumulate. In the fields one finds hardly 1 per 1,000 of the anopheles which transmit malaria, infected, and in the huts where the labourers keep their implements, and which are found scattered through the fields, none are infected ; in the villages, on the other hand, the number rises to 5 per cent. It has been found that by suppressing the small breeding grounds, pools, wells, &c., in the villages malaria disappears. It should be noted that this does not refer to æstivo-autumnal fever, which is stated not to occur once the land has been brought under cultivation. The provision that rice should not be grown where other cultivation is possible is not strictly observed, and the author believes rightly. What the law should consider is whether the soil is sufficiently drained to prevent the formation of permanent marshes. Equally important is to insist that the quantity of irrigation water available is sufficient to preserve a constant current in all parts of the area, including the channels of supply and drainage. The law should aim at the prevention of the formation of areas similar to the marsh lands where æstivo-autumnal fever is spontaneous.

With regard to the prohibition of obstacles to the circulation of the wind, the author holds that it is difficult to find facts in favour of this restriction. On the contrary, it is more reasonable to suppose that barriers might be effective in limiting the area of dispersion of the mosquitoes, and that under certain circumstances woods or avenues of trees might be a defence against infection. The minimum distance laid down by the law to intervene between the fields and dwellings is also not in accord with the facts. The form of paludism which rice cultivation might induce is the same as that liable to be caused by any other badly established cultivation

under irrigation, and requires no distinctive legislation. Properly carried on (in the words of a very competent expert), rice cultivation might be indulged in without danger at the very door of the church. In practice, the methods of cultivation adopted are as hygienic, as a rule, as they are admittedly excellent from the agricultural point of view.

The conclusions proposed by the local committee in the form of a series of resolutions embodying the above views were open to objection on the ground that they contained a criticism of the existing laws of Spain. The foreign delegates pointed out that they would be unable to express an opinion or take part in voting on them. Accordingly they were replaced by the following, which were unanimously adopted:—"(1) That the cultivation of rice modifies land subject to malaria in the direction of making it more healthy. (2) It is advisable to facilitate the making more healthy of obviously marshy lands, even when they are found at a less distance than that authorised by the law."

It will be seen from the above exceedingly condensed review that the subjects dealt with covered a very wide field and that most of them are of direct interest, in one way or another, to even so remote a country from Spain as India. The individual delegates profited as much by the opportunities afforded of getting into relations with the representatives of other rice-growing countries as by the Congress meetings proper. Much of the success of the meeting was due to the personal efforts of the Count de Montornés, one of the foremost proprietor-agriculturists of Spain, whose model estate was well worth a visit. His extraordinary energy in and out of the Congress was evident at every turn. Each delegate was made to feel that it was the special object of the President and local committee to obtain for him every information that he might desire, and to give him every facility in getting into touch with local and foreign members who might be of use to him. It was in this respect the perfection of organisation. From the technical aspect the contributions of the Italian delegates were the most important. Their description of the work done in Italy on the testing of new varieties, on the introduction of improved

implements, and, in particular, of the methods adopted in fighting *brusone*, of which no complete account has been published, were of great interest.

The next Congress will be held in Marseilles in the summer of 1916.

NOTES ON THE FODDER PROBLEM IN INDIA.

ARRANGED BY

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(Continued from page 58 of Vol. IX, Part I.)

IN the first set of these notes which appeared in the last January number of this Journal the present writer recorded the results which had been achieved in efforts to introduce exotic drought resisting plants and also gave in detail an account of what had been attempted in the various Provinces in the way of combating fodder difficulties in times of scarcity.

During the year 1913 two very important and representative bodies considered the question of fodder from the special point of view of forests and from the more general agricultural standpoint. At the meetings of the Indian Board of Forestry which met at Dehra Dun in March, 1913, the utilisation of forest grasses was considered. The basis of these discussions was a note drawn up in the office of the Inspector-General of Forests on the efforts hitherto made to utilise fodder grass from forest lands. It was noted that this utilisation of grass for fodder is of greater importance in Bombay, Madras, and the Central Provinces than elsewhere, and that, in these provinces, the subject has already received much attention. "In Bombay the sole right to cut and collect grass from certain forests has been given to a contractor on the condition that he shall maintain for Government a supply of 25 lakhs of lbs. of baled grass from the 15th April to the 15th October of each year. In Madras the people are slowly learning the value of cut fodder, and in 1911-12 the right to cut grass in certain reserves in which hay has been made

by Government in previous years, was sold at the request of the villagers themselves. In the Central Provinces the policy adopted is to cheapen the cost of cut fodder and to raise the grazing fees. In Assam and Burma, where the rainfall is usually ample, and where grazing is not, as a rule, excessive, the question is not of great importance. In other provinces there are special difficulties, such as almost unlimited rights to grazing, which greatly hamper progress."

The general conclusions arrived at by the Board of Forestry were as follows :—

(*i*) That a given area will supply fodder grass of better quality and in greater quantity when cut than when continuously grazed.

(*ii*) That private enterprise is more likely to effect the object in view than operations undertaken by Government ; but that departmental operations may be necessary in places to give a lead to private enterprise and to show the financial results of working.

(*iii*) That the policy of " cheap grass and dear grazing " as followed in the Central Provinces, but modified to suit local conditions, is likely to lead to the best utilization of fodder grasses.

(*iv*) That the incidence of grazing in open areas should be carefully regulated, and every encouragement given to the extension of the area closed to grazing. In closed areas, grass cutting should be permitted at such seasons as will ensure a maximum annual yield, such areas being situated as near as possible to the centres of consumption.

(*v*) That the grazing of nomadic cattle should be confined to certain fixed areas.

(*vi*) That improved communications are likely to lead to the extension of grass cutting operations.

(*vii*) That the substitution of stall feeding for grazing which, from the point of view of forest administration, is much to be desired is extending slowly in Bombay, in the Central Provinces, and in other places where favourable conditions as to supply and market

obtain ; but that the villager is not likely to take generally to stall-feeding until higher grazing fees are imposed.

(*viii*) That the storage of grass by Government is not desirable, except when considered necessary to meet the initial demand at a time of fodder famine.

(*ix*) That the question of transport, in regard both to railway freights and the supply of railway wagons, is a real difficulty. To encourage a more general use of cut fodder, low rates of freight, and a steady supply of wagons at grass exporting railway stations are necessary. In order to reduce the demand for wagons, steam baling presses should be used in places where the outturn is large (say 2,000 tons) since steam pressed bales are only half the size of those of equal weight pressed by hand.

The Government of India accepted generally the recommendations of the Board of Forestry. "They agree that in parts of the country where the demand on the forests for grazing is unusually heavy and is not confined to cattle which can be properly classed as agricultural, the policy adopted in the Central Provinces of increasing the dues for commercial cattle is worthy of consideration. They also recognise the necessity for regulating the grazing incidence and the desirability of using steam presses for baling grass so as to reduce the demand for railway wagons. The question of railway freights for the carriage of fodder was however considered as recently as 1910, and the Government of India are not prepared to urge the railways to make any special concession in this matter, except in times of scarcity.

"Clause (*vii*) of the Resolution was discussed by the Board mainly from the forest point of view, the Forest Department being interested in the matter, because the substitution of stall-feeding for grazing would tend to decrease the demand for grazing in the forests, and to increase the market for the sale of forest grass, which in many places is little utilised at present. The Government of India realise that the question of the substitution of cut fodder for grazing must be fully considered from the general agricultural point of view before any definite or far-reaching policy can be adopted. Experience in Madras, Bombay, and the Central

Provinces suggests however that in certain circumstances and in certain localities action on the lines proposed by the Board may have beneficial results from the agricultural point of view as well as from that of the Forest Department."

The second representative body which considered the question was the Board of Agriculture in India which met at Coimbatore in December, 1913. The subject was dealt with by a Sub-Committee of the Board under the chairmanship of the Hon'ble Mr. H. R. C. Hailey, I.C.S., Director of Land Records and Agriculture of the United Provinces, and the first set of these notes which appeared in the January (1914) number of this Journal was taken as a basis of discussion. The Report of the Sub-Committee on the questions of fodder and cattle foods runs as follows :—

"The fodder question appears to arise in very different degrees of acuteness in various parts of India. In some provinces, such as parts of Bombay, the Central Provinces, the United Provinces and the Punjab, the question turns largely on the maintenance of a sufficient supply to prevent the great loss of cattle in famine years. In other provinces and other parts of the above provinces the danger of anything like a fodder famine is somewhat remote, and the problem centres rather round the prevention of waste and the using to the best advantage of the existing material. In irrigated tracts, for instance, there can never be any actual fodder famine though there may be an insufficiency of supplies owing to the crop system in force. In such tracts it is idle to recommend the growing of drought resisting plants, whereas these may be of great value in dry parts of the country. The problems to be attacked therefore are essentially of a local character and must be worked out from the point of view of particular localities and nothing more than very general recommendations can be made."

The recommendations of the Committee are :—

"(1) *That investigation should be made in each province of the existing sources of fodder supply and their utilization to the best advantage.* Among other possible sources of supply to which attention might be directed are the bye-products of the cotton seed crushing mills. Experiments undertaken at Poona have tended to

show that cotton hulls are of considerable value as fodder. It is also suggested that certain grasses at present grown on a limited scale possess high nutritive value.

"Among possible methods of utilization of existing supplies further attention might be paid to ensilage and to the cutting and storage of grass for hay. The present methods are not merely wasteful but tend to lower the nutritive value of the hay.

"(2) *Encouragement of cultivators to include some fodder crops in their rotation.*—This is essentially a local problem on which no particular recommendations are called for. It appears however desirable to consider whether the object in view cannot be furthered by the lowering of the canal rates for such crops in irrigated areas.

"(3) *Stall-feeding.*—The Committee are of the opinion that no efforts to popularize stall-feeding are necessary. It is being forced on the cultivators in certain tracts by economic conditions and will doubtless be forced on them in a larger measure in the future. It should, however, be pointed out that stall-feeding must as a general rule be more expensive than grazing. As the pressing problem at the present moment is to increase the number of cattle, stall-feeding cannot from this point of view be recommended in substitution of grazing where facilities for the latter are already in existence. Further the Committee would point out that, because in exceptional circumstances and on a limited scale, the sale of grass from forests has proved successful, it cannot be argued that it will prove equally successful in all cases or over wide areas of forests. For instance, in parts of the Central Provinces and Berar, where the jungles encroach on, or are surrounded by, highly cultivated cotton tracts, the demand for grass is so keen that it pays to cut the grass and stall-feed; but in most other tracts of the Central Provinces the jungles are more remote so that the cutting and removal of grass from the jungles to the villages for the purposes of stall-feeding appears impracticable. Much of the forest grass too when cut and baled under present conditions is so rank and coarse as to be unpalatable to cattle and possesses a very low nutritive value.

"(4) *Storage against famine.*—Experiments should be undertaken as to the best methods of storing hay and various forms of

fodder and demonstrations of the methods recommended given. The co-operative societies would probably form most useful agencies for carrying out these methods. The experiments now being undertaken in the Bombay Presidency for shredding and baling *karbi* appear to offer a possible solution of storing this form of fodder and, if ultimately successful, the process might be usefully adopted in other tracts subject to famine.

"(5) *Prickly Pear.*—The experiments undertaken in the Bombay Presidency go to show that the prickly pear, if properly prepared, forms a useful food in famine times. It would also be profitable to feed it as part of the ration when fodder is scarce and prices high. Demonstrations might be given in other parts of the country subject to famine where this plant is found.

"(6) *The relative food values of Indian cattle foods.*—The Committee are of the opinion that a systematic investigation of the subject is desirable and should be best undertaken at Pusa, the necessary staff being entertained to carry out the work. In addition investigations should be conducted at the provincial farms to ascertain, by such methods as weight measurements, the relative feeding values of the different grasses grown in the provinces."

This report was accepted by a majority of the Board but, with reference to the investigation of the relative values of Indian cattle foods, the general feeling was that to be thorough this investigation must be strictly scientific (compare Kellner's work at Möckern) and that it could only be carried out by a special staff with special equipment such as could not at present be justified by the comparative importance of the results likely to be obtained.

The difficulties in obtaining accurate results without most elaborate scientific detail and precautions were emphasised by such experienced officers as Col. Pease, Mr. Dobbs, and Mr. Wood, and it was felt that, while such general conclusions as those quoted by Mr. Clouston and Mr. Hamilton, *viz.*, the establishment of the value of a particular grass or of cotton seed and cake as a feeding stuff, might be arrived at by actual feeding tests: to be complete more scientific and elaborate tests, with apparatus of the kind used in Germany and America, would be required and that, at this stage,

such elaborate and expensive investigation is hardly justified. At the same time there seems no reason why an analysis of the actual food constituents, *i.e.*, proteids, etc., of the various fodder and food crops of India should not be made either by all Agricultural Chemists or as a central piece of work by one Chemist. Apart from absolute scientific accuracy the information would be of considerable practical value. A beginning on these lines was made by Mr. Collins when Assistant Agricultural Chemist to the Government of India and it might well be extended.

In these notes the writer has done nothing more than attempt to put the interested public in possession of the latest information on the subject of fodder and feeding stuffs. It is hoped the impression left will be that amidst their many varied duties the Agricultural Departments are not forgetful of what they owe to the cattle of India on whose maintenance in health and strength the possibility of all agricultural achievement depends.

THE USE OF FISH AS CATTLE FOOD.

BY

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DURING the closing months of last year, and the beginning of this, an experiment was conducted at the Central Farm, Coimbatore, to ascertain the possibility of using fish as a food for bovine stock, and ascertain what value, if any, this somewhat novel food had for the purpose.

The experiment was begun at the instance of Sir Frederick Nicholson, K.C.I.E., the Honorary Director of the Madras Fisheries Bureau, who suggested at first the use of *Fish Guano* as a cattle and poultry feed. His description of this was as follows :—

"It is the result of boiling good fresh whole sardine and nothing else ; except the natural contents of the guts of the sardine (mostly removed in the boiling, etc., processes), there is no admixture of anything that is not tissue and bone of sound fish ; there is no sand or foreign addition, as there generally is in the ordinary beach-dried 'fish-manure ;' and it is absolutely free from taint and has been sterilised by steam boiling." At the same time Sir Frederick Nicholson suggested that it might be feasible to use ground *dried* fish for the purpose proposed, which, prepared as he was then preparing it, free from sand and absolutely without taint, would cost less than half the guano. Subsequently Sir Frederick Nicholson sent copies of various articles culled from the *Fishing Gazette* (New York), in which reference was made to the practice of utilising various fish products, guano, fish meal and so on, for cattle food in various parts of the world. It seems that in Shetland and Iceland

dry salt fish constitutes an important feed for cattle and sheep and even horses.' It is not without interest to learn that in 1853, experiments carried on by Sir John B. Lawes at Rothamsted, on the feeding of pigs, included the trial of dried Newfoundland cod fish. The fish was fed with maize, barley, and bran, in different proportions, and Sir John Lawes reported that 'in these pens the pigs were very fat and well ripened,' and there was a very good proportion of increase to food consumed. He concludes 'this result is in itself interesting, and it may perhaps point to a comparatively greater efficiency in the already animalised protein compounds supplied in the cod fish than in those derived, as in the other cases, from the purely vegetable diets.'

Other references might be quoted, but it was soon clear that the feeding of such substances was not the absolute novelty it had at first appeared, and it was decided to undertake a definite test. Curiously enough, soon after receiving Sir Frederick Nicholson's letter, the writer heard of the practice of feeding mutton to special cattle kept for display of strength at village festivals in Nandyal, while it also seems a fairly common practice to make use of bandicoots when killed, by pounding them in a mortar and feeding them to cattle.

The first sample of dried fish, received from the Government Depôt at Tanur, was analysed by the Government Agricultural Chemist ; the figures are given below :—

Analysis of whole Fish.	Per cent.
Water	17·90
Insoluble mineral matter	2·48
Soluble mineral matter	32·19
Oils and extractives	3·21
Crude proteids	40·75
Carbohydrates	3·47
	100·00
Containing—	
Albuminoids	30·10
Phosphoric anhydride (P_2O_5)	6·87
Potash (K_2O)	0·37
Lime (CaO)	7·78
Total Nitrogen	6·52

The samples actually used did not correspond exactly with this, and probably contained slightly more salt. They are described by Sir Frederick Nicholson as 'pilchardised.'

"The ungutted sardines are thrown into *brine*, or rough salted for a varying but short period, just as they come from the sea: they are then dried and are perfectly fit for consumption.

"The word 'pilchardised' is used because the Cornwall pilchards are salted ungutted. The samples were from several batches which had received slightly different methods of treatment."

The experiment was begun on the 5th of September under the instructions of Mr. Sampson, who was then acting as Principal and Superintendent of the Farm. Previous experiments conducted with working animals had shown that it was not easy to arrange for uniform work, and that the animals' live weights underwent wide variation at comparatively short intervals. Though it would perhaps have been more interesting to have noted the success of a fish diet on mature working animals, it was decided for experimental reasons to test it on young heifers. Ten were accordingly selected: ranging in age from 20 to 30 months and in weight from 316 to 508 lbs. The table below shows how they were divided:—

How Fed.	Number of Heifer.	Age in months.	Weight.	Monthly rate of increase.
Fish diet		28	476	17·0
		29	460	15·8
		27	428	15·8
		24	344	14·4
		29	352	12·1
Average	..	27·4	412	15·02
Ordinary diet	49	30	508	16·9
	62	26	352	13·5
	74	20	316	15·8
	51	30	432	14·4
	59	27	404	15·0
Average	..	26·6	402	15·12

These animals were, at the time of the experiment, on the following daily diet, so far as their concentrated food was concerned :

Cotton seed	½ lb.
Groundnut cake	½ ,,
Dholl husk (*Cajanus indicus*).	½ ,,
Salt	¼ tola

Analysis showed this to contain 0·329 lb. Albuminoids, 0·483 lb. Carbohydrates, and 0·122 lb. fat ; disregarding the digestibility of the various substances, the albuminoid ratio works out to 1 : 2·3. In order to deviate as little as possible from this, the following ration was selected by Mr. Sampson :—

Rice bran	14 oz.
Dholl husk	½ lb.
Fish	¾ ,,

This gives the following figures :—Albuminoids 0·310 lb., Carbohydrates 0·517 lb., and fat 0·102 lb., with an Albuminoid ratio of 1 : 2·4.

The fish was ground in a disintegrator, and mixed in with the soaked bran and husk just before feeding, and the usual precautions were taken to introduce the animals gradually to the new diet.

The animals did not at first take kindly to the fish ; they did not clean out their pans with the keenness shown by the animals on the ordinary diet, and it was not until the end of November, six weeks after the beginning of the experiment, that they ate it readily : since then, until the end of the experiment in the middle of March, no trouble occurred, and the animals seemed to find nothing distasteful in their diet.

So far as their health was concerned, the animals fed on fish kept perfectly healthy throughout the six months of the experiment, and no ill effects of any sort were noticed. Of the ten heifers, three on the fish diet, and only one on the ordinary diet, came into season and took the bull : it is insufficient evidence, but there certainly seems some reason to suppose that the fuller flavoured food had had some effect.

The live weights of the animals were taken weekly throughout the experiment. The best idea of the relative increase of the two lots may be obtained by taking the differences between the averages of the first three weighments and the last three weighments in each case. The figures are given below :—

Ordinary Diet.

Number of Heifer	62	49	51	59	74
Average of first three weighments	360	507	455	428	325
Average of last three weighments	439	592	478	523	396
Increase	79	85	23	95	71

Fish Diet.

Number of Heifer	53	55	52	58	68
Average of first three weighments	370	498	472	412	364
Average of last three weighments ..	421	561	533	435	435
Increase	51	63	61	23	71

The total average in each case may be obtained from these figures and is in the case of the fish diet just under 54 lbs. per head for the whole period, as against an average gain of 70 lbs. per head for the heifers fed in the ordinary way. The test seems a fair and conclusive one : the individual variation of the animals is evidently not excessive : each group contains one unthrifty animal whose exclusion does not alter the figures obtained above. It is clear that the fish diet is inferior to the other, to the extent shown by these figures. This inferiority may be termed a quantitative and not a qualitative one, since, as noted above, the animals fed on fish were perfectly healthy throughout. The question must accordingly be decided from the point of view of the relative cost of the two diets, and this will be largely affected by the locality, as the freight from the coast will have to be taken into consideration. Further, owing to the great fluctuations in the supply, it is not possible to strike an average figure to represent the cost of preparation. The following is quoted from

Sir Frederick Nicholson: "In South Malabar in 1912-13 there was hardly a single shoal of fat fish worth boiling for oil and 'guano,' while the small lean fish, running at from 70,000 to 100,000 per ton, were so numerous that the beaches were *covered* with 'fish manure,' the merchants' godowns were crammed, and I myself bought fresh fish at Rs. 3 per ton, which might mean below Rs. 20 per ton of dried fish as actual cost. This year, 1913-14, opened promisingly with fair quantities of fish, but for several months we have literally not seen a sardine, and my last purchases—months ago—were at Rs. 12 per ton, after which only a few baskets have been obtainable at any price. Hence I can give you *no* table or even approximate figures of 'cost.'"

The present trade value of dried fish, milled and *free from sand*, bagged and free on rail on the West Coast, is about Rs. 50 to 60 a ton, and this will probably rise as the value of the produce becomes more widely known, since Ceylon, the Straits Settlements, and Japan are already in the market for all classes of manure, besides the increasing local demand for both plains and hill cultivation. It is difficult therefore to say with any precision whether it is profitable to introduce it as a regular feed, but probably it is not. There is a slight difference in the cost of the two rations used in the experiment in favour of the fish (at Rs. 50 per ton delivered), but put alongside the smaller gain in live weight, there is nothing in it.

The general conclusions drawn are that no ill effects follow from the addition of fish to a mixed ration for cattle; and that after a little time no trouble is experienced in getting the cattle to eat it freely. So far as its fattening value is concerned, the fish does not compare favourably with groundnut. From a financial point of view, fish is not to be recommended for inland localities, though it is probable that on the Coast itself, in favourable seasons especially, a considerable saving might be effected by its use.

OPUNTIA ELATIOR, MILL.

THE PRICKLY PEAR OF THE BOMBAY PRESIDENCY.

BY

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The term "prickly pear" is commonly applied by English-speaking people to flat jointed members of the botanical genus *Opuntia*. The general term "prickly pear" has unfortunately been used, in work on the fodder value of the plant, without mention of the species. This is a source of confusion, since the species of *Opuntia* differ in their value as food for cattle, and in many other things of practical importance. One of the essential points, therefore, in reporting work on "prickly pear" is to know exactly the species dealt with.

This is by no means so easy a task as it looks, and there is still some disagreement as to the nomenclature of the *Opuntia* described in the present paper.

In Hooker's *Flora of British India* the only *Opuntia* mentioned is *Opuntia Dillenii*, Haw. In Cooke's *Flora of Bombay* mention is made of *Opuntia Dillenii*, Haw, and *Opuntia nigricans*, Haw, and the latter is referred to as having spread widely throughout the Deccan. The present writer was accustomed to use the name *Opuntia nigricans* for the Bombay prickly pear until the publication of Burkill's paper "Determination of the Prickly Pears now wild in India" (*Records of the Botanical Survey of India*, Vol. IV, No. 6, October 1911). In this, Cooke's *Opuntia nigricans* is determined as *Opuntia elatior*. The original paper should be referred to for

1. Joint producing roots and new joints. 2. Joint flowering.
3. Joint fruiting. 4. Fibrovascular skeleton of joint.

Fruits producing vegetative growth.

the reasons of the change of nomenclature, to which the present writer will adhere. At the same time it should be mentioned that the excellent coloured plate of *Opuntia nigricans* given in the *Agricultural Gazette of New South Wales*, March 2, 1912, facing page 210, is undoubtedly the plant called *Opuntia elatior* by Burkill.

An individual plant varies from 6 to 10 feet high. The joints are obovate in outline, and green. The size of the joints varies a good deal according to conditions of water and shade. They may reach the dimensions of 18″ long × 12″ broad; but the average in the Deccan is 9″ × 5″. The thickness varies with the water-supply. In the hot weather the joints are contracted and wrinkled, while in the rains they are swollen and succulent. The fibro-vascular system of a joint is shown in Plate XXXI, Fig. 4. This joint was naturally skeletonised by the weather and it is a proof of the toughness of the fibre that the skeleton should be so perfect. The joints are very mucilaginous, have a large central water storing tissue and a many-layered epidermis, with calcium oxalate even in the outermost layer.

The sizes above-mentioned do not, however, apply to the first shoot from the ground level. Whether this shoot comes from a seedling or a cutting, the first joint is always exceedingly long in proportion to its breadth. Two actual cases measured gave the sizes 5″ × $\frac{3}{4}$″ and 13″ × $2\frac{1}{2}$″ respectively. This elongation may persist through one or two succeeding joints as shown in Plate XXXI, Fig. 1. It is possible that it may be an adaptation to the necessity for getting up to the light quickly. It must be mentioned, however, that the elongation occurs in the first joints of plants in exposed situations, so that it is now a fixed character and independent of the light conditions in the environment.

Plate XXXII, Figs. 1—4 show the groups of spines when young and when mature. In the mature joints the spine groups are $1\frac{1}{4}$″ to 2″ apart in quincuncial fashion, except at the edges, where they are crowded, especially near the apex. In the young joint the reduced body (*b*) which represents the leaf may be seen under each spine group. This falls off before the joint is full sized.

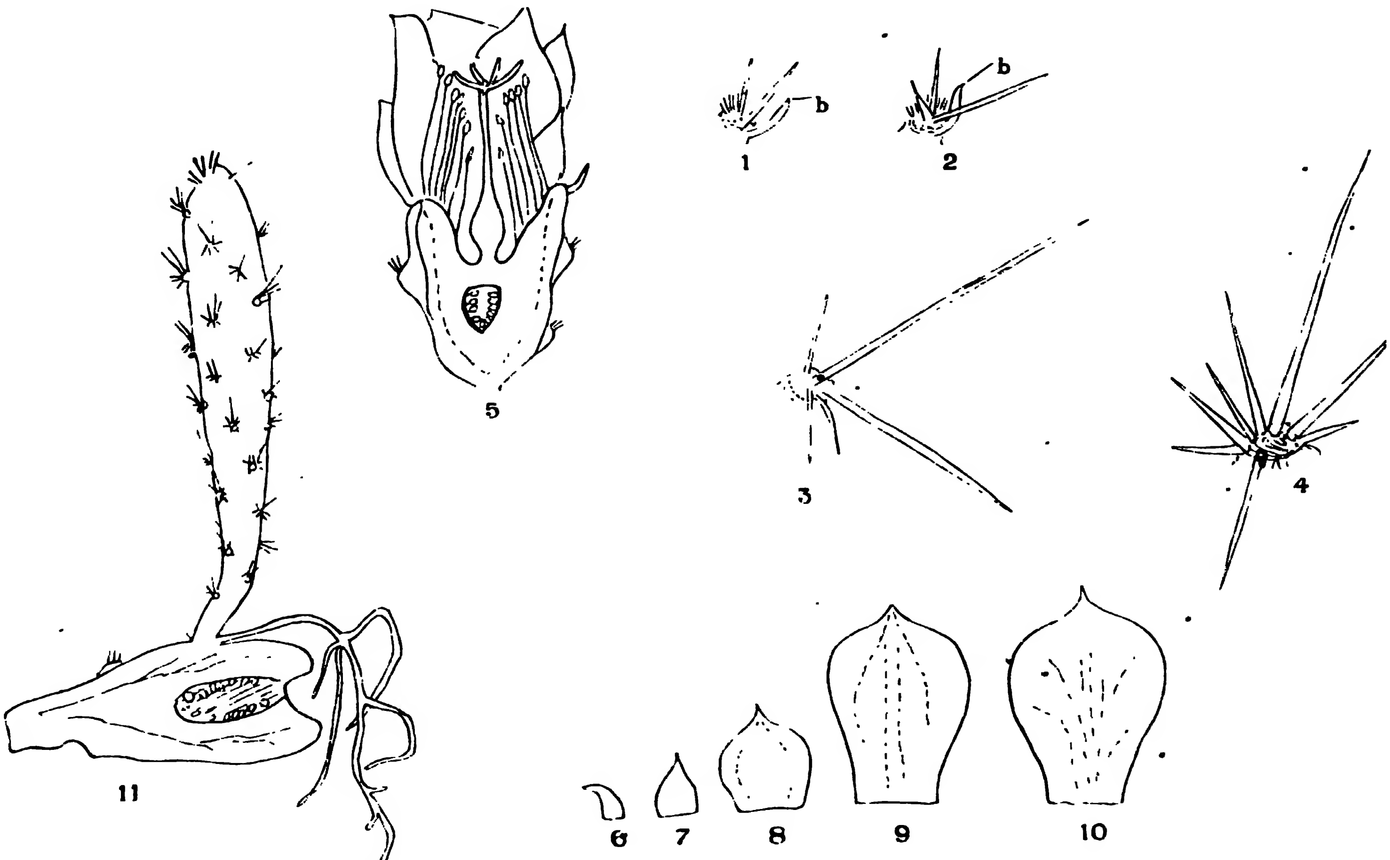
At the base of the large spines is a cushion of small, tawny, very irritating yellow spines. The larger spines vary in number and size, but one is often somewhat larger than the rest. Plate XXXII, Figs. 3 and 4, show the natural size of these. They are usually tawny with black bars when ripe, but may also be pure black.

Branching takes place from the exact apex of each joint and also from the edge of the joint, just below the apex. There is a tendency for the joint at the apex to be at right angles to the joint below, while the joints from below the apex are usually in the same plane as the joint from which they spring. One can easily see that this arrangement will on the whole tend to increase the stability of the plant. As the plant gets older the basal joints of the plant become round and are covered with dead grey bark.

The flowers (Plate XXXI, Fig. 2) are borne on the edges near the tops of the last-formed shoots. The main flowering season is in July and August among plants near Poona. The flower is shown in section in Plate XXXII, Fig. 5. The ovary is deeply sunk in a green fleshy torus protected by spines of the same type as those on the joints, but smaller, and with the tufts more closely together. There is no distinct calyx and corolla. Plate XXXII, Figs. 6—10, show the gradual transition from a small thick bract to the membranous inner "petals" of the flower. The relative position and ripeness of stamens and stigma show that self-fertilisation is probable. The "petals" close up later on (Plate XXXI, Fig. 5), and the "petals," stamens, style, and stigma finally fall off leaving the still green young fruit behind (Plate XXXI, Fig. 3). This becomes deep crimson when ripe and the inside is edible. Burkill, in the paper previously cited, distinguishes thus between *Opuntia nigricans* and *Opuntia elatior*:

Flowers orange	*Opuntia nigricans*
Flowers at opening lemon-yellow changing to rose pink ...	*Opuntia elatior*

The colour of the "petals" undoubtedly changes to rose pink and hence it may be assumed that the name *Opuntia elatior* is correct.



1, 2. Spine tufts on a young joint.
3, 4. Spine tufts on a mature joint.
5. Section of flower.
6-10. Members of outer and inner wherls of flower perianth.

The propagation of this plant is effected in various ways. Seedlings are produced but are rarely observed. The two cotyledons are thick, fleshy, green and *absolutely spineless*. They soon fall off and the plant then proceeds to develop its long underground roots and elongated first joint.

Propagation from severed joints is often seen. Such joints have an extraordinary vitality. They may have lost all their greenness and yet remain succulent and ready to produce roots. In May 1913, on the land of the Agricultural College Farm, Poona, some *Opuntia elatior* was cut down to the ground, uprooted, burned on the spot, and the rubbish carted away. In May 1914 some of the joints which had escaped complete destruction were giving out new joints and had established roots in the soil. Such roots develop from the sites of the spine tufts. Even when a cut is made across a joint and the cut end inserted in soil, the roots come from the sites of the spine tufts below soil and not from the healed cut. Plate XXXI, Fig. 1, shows the result of such an experiment. The cut joint was planted in a pot in June 1913 and photographed in June 1914. It had made a few long straggling roots and the joints above itself. A method of propagation which the writer has repeatedly observed is represented in the second photograph in Plate XXXI, where an unripe fruit planted in the soil develops vegetatively from one of the spine tufts just as if it had been an ordinary joint. Plate XXXII, Fig. 11, shows a section through such a fruit demonstrating that there is no connection whatever between the plant produced and the unripe seeds in the ovary.

The root-system of the plant as it is found in the field is extensive. Roots have been traced to 6 feet away from the centre and 3 feet deep. The roots are exceedingly tough, and contain crystals of calcium oxalate in considerable quantity.

When one takes into consideration all the advantages and protective qualities possessed by this plant, and in addition its extraordinary power of vegetative propagation, it is not to be wondered at that it is difficult to *completely* eradicate it where once it has become well established.

TURF.

BY

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THE successful growth of turf depends in India, as it does in Europe, upon the selection of those grasses most suited to the local conditions of soil and climate and the purpose for which the turf is required. In England a mixture of several kinds is generally used, whereas in India, at least in a very large number of places, the production of a pure culture of *doob* (*Cynodon dactylon*) is most commonly aimed at, and this for various reasons, mostly good ones. *Doob* is easy to grow, and with proper treatment gives a good surface for golf or tennis ; it is not a good grass for polo grounds, being slippery and treacherous, and requiring more care and attention than most polo clubs can afford to apply to twelve acres of turf. It is liable to form thick mats of growth in some spots and to die out in others owing to inability to compete with other deeper rooted grasses in the dry season, either for food or water. This disability can be overcome on the small scale required for tennis courts and putting greens, but twelve acres of polo ground is a large area to water, manure, and hand weed. The same remark applies to cricket grounds, and in addition it may be pointed out that a *doob* wicket-table requires special preparation, entirely different from that of the outfield, generally involving the use of clay. For the outfield of a cricket ground, for polo, and even for hard-worked tennis courts nothing is better than a judicious mixture of coarse grasses, but the trouble lies in proper selection, if the condition of the soil and climate is not such as to produce a natural mixture which cutting, rolling,

sanding, and manuring will turn into a good composite turf. Such a mixture will stand much more hard work and resist drought better than a pure *doob*, and many coarse grass tennis courts have as good a playing surface as any made of *doob* alone.

Nevertheless *doob* is so much more easy to grow, and the use of one well-known grass instead of a mixture containing individuals whose habits and requirements are not so familiar, simplifies its treatment. The intention of this article is to describe the writer's experience of making *doob* turf at Pusa in the hope that the methods adopted may be found of use elsewhere. It should be stated, however, that the writer's experience of the use of ammonium sulphate for this purpose has been limited to this particular soil, and although the general principle of treatment remains the same for any soil on which it is desired to grow *doob*, yet it may be necessary in other localities to include lime or basic slag in the application, this not being necessary at Pusa owing to the large quantity of the former already present in the soil.*

The ordinary practice adopted for making a *doob* lawn is to remove the surface growth entirely, plough or hoe the soil itself, remove grass roots, and dry out weeds by exposure to the sun. The surface is then levelled and plastered over with a mixture of mud and cowdung in which the *doob* is planted. This method produces a *doob* lawn in a remarkably short time, but it has disadvantages, amongst which may be reckoned the following :—

(1) The use of cowdung reintroduces an enormous number of weed seeds which germinate later and make constant weeding necessary.

(2) The mud plaster generally used produces a surface which dries hard and cakes when rolled and when the sun gets on it; such a surface is prejudicial to vigorous plant growth and especially bad for turf.

It has been found better, in this method of making a lawn, to replace the cowdung by using either oil-cake or sterilised animal

* If lime is required it must on no account be applied at the same time as the sulphate of ammonia, but should be put on not less than two months later.—C. M. H.

meal, the latter being a preparation of slaughter house refuse obtainable from Calcutta and containing about 8% nitrogen. Oil cake, if fresh, should be kept for at least six months before use, and finely powdered before application.

In cases where it is required to make a tennis court or putting greens out of grass land, or to improve the condition of already existing ones the method hereinafter described has been found successful; it must be stated, however, that success has depended upon the presence of a certain proportion of *doob* amongst the other grasses present, and although the use of ammonium sulphate and sand in the manner prescribed has been eminently successful at Pusa both for maintaining the condition of putting greens laid down with pure *doob* from the start and for creating *doob* greens out of the mixed turf grasses normally found there, this method applies more particularly to the latter condition and has been worked out with special reference to it; the writer's object in carrying out the experiments on renovation of turf was mainly in connection with the use of the latter as a standard crop for measurement of the relative manurial value of various agricultural operations depending upon bacterial action; perennial turf grasses respond rapidly to applications of available nitrogen and the obvious and rapid character of this response makes it possible to use them as qualitative indicators of the presence of nitrogen in this condition. Thus the difference between the relative availabilities of nitrogen as sodium nitrate and ammonium sulphate can be seen at a glance when these are applied to a *doob* plot, as a darkening of colour which may occur in the case of sodium nitrate within 24 hours and in that of ammonium sulphate generally a day later at the earliest.

Doob is a shallow rooted plant and obtains its food from the surface layer of soil; most of the other grasses, with which it has to compete, such as *motha* (*Cyperus rotundus*), *dabhi* (*Imperata arundinacea*) and *rari* (*Saccharum spontaneum*) are comparatively deep-rooted; now the keenness of competition between plants growing close together, as turf grasses do, is very great, and the ultimate survival of individual kinds is determined by quite small initial differences in their relative power of obtaining either

food or water. Taking a mixture therefore of deep and shallow rooted grasses, and supplying plant-food which tends to remain near the surface or to undergo only near the surface such changes as are necessary to make it easily assimilable by plant roots, the result will be the gradually increasing growth of the shallow rooted plants and a corresponding diminution in that of the deeper rooted kinds. Experiment has shown that nitrogen is the chief requirement of the *doob* grass plant and indeed this grass responds so quickly to nitrogenous manures that it is possible in many cases to produce a good growth of it simply by heavy dressings of such materials as oil cake or cattle manure, but the results are not so certain nor the character of the growth so good as may be obtained by the use of ammonium sulphate. It is a fact, well-known to agricultural chemists that salts of ammonia, such as ammonium sulphate, are retained by the soil to which they are applied, whereas another nitrogen-containing compound, nitrate of soda, is easily washed down through it by rain; thus an application of nitrogen in the form of sulphate of ammonia will tend to remain near the surface whereas one of nitrate of soda will tend to move downwards. This is the underlying principle suggesting the use of sulphate of ammonia for encouraging the growth of *doob* at the expense of other deeper rooted grasses. In practice, it has been found at Pusa that the application of sulphate of ammonia to very bad turf containing in addition to *doob*, *motha*, *dabhi*, *rari*, *apang* (*Andropogon annulatus*), *tetar* (*Launea asplenifolia*), and *dudhi* (*Euphorbia thymifolia*) results in the eventual elimination of everything except the *doob*. This result was obtained in the cold weather beginning in November, when, owing to comparatively low temperatures and scarcity of soil moisture, the competition between individuals would be keener than during the rains, thus allowing the treatment to have full effect. It is not certain that the method would be equally successful during the rains, although the use of sulphate of ammonia at the latter time of year produces a vigorous fresh growth of *doob* on putting greens and tennis courts already possessing a fair proportion of this grass.

In the first experiment carried out, beginning on 5th November 1913, a piece of very bad ground which had never been planted with *doob*, was cut and rolled and divided into eight plots measuring 10 feet × 10 feet each. These were treated as follows :—

A and AI sulphate of ammonia and superphosphate ;

B and BI sulphate of ammonia alone ;

C and CI no manure ;

D and DI sterilized animal meal ;

AI, BI, CI, and DI were also covered with a thick layer of coarse sand.

The amounts applied calculated per 100 sq. feet were as follows :—

Ammonium sulphate 3·5 lbs. | Superphosphate 8 lbs.
Sterilized meal 3 lbs.

The ammonium sulphate was dissolved in water and applied with a watering pot, the amount used being ammonium sulphate 3·5 lbs. in 4 gallons of water to each 100 square feet of turf.

Thus for a tennis court 78 × 36 feet 98 lbs. of ammonium sulphate would be required. Before treatment the ground showed patches of bare soil with scanty growth of poorly nourished plants of *dabhi*, *motha*, *apang*, and *doob* with some *rari*, *tetar*, and *dudhi* ; in 48 hours after treatment all these plants, including the *doob*, appeared to be dead, being brown and burnt ; two days later fresh green shoots of *doob* were found which gradually covered the bare patches, and in one month's time, with no further treatment except daily watering and periodic cutting, the whole surface was covered with a nearly pure culture of *doob*. This was in the case of ammonium sulphate alone or with sand ; where superphosphate had been added but no sand, a bad blackening of the soil with no growth occurred in patches ; this had been prevented by the addition of sand, but in both the superphosphate plots, although eventually covered with a thick growth of grass, this was not pure *doob* but contained many plants of *apang*, *dabhi*, and some *motha*, which seemed to be sufficiently strengthened by the phosphate to stand competition with the surrounding *doob*.

The sterilised meal plots were very promising at first, especially the sanded one, which after six weeks' growth (in November and December) compared favourably in appearance with the ammonium sulphate plot. Examination however showed that a large number of plants of *apang* and *dabhi* were present and after eight weeks the whole plot began to lose colour and develop patchiness due to failure of the *apang* and *dabhi* to make equal growth with the *doob*. The result was unexpected as it was supposed that the sterilised meal would supply nitrogen slowly and regularly by nitrification of its organic nitrogen content and that this supply would consequently continue for a much longer period than would be the case with ammonium sulphate ; the plots to which the latter was applied, however, showed no signs of falling off in colour or condition until the middle of January when it was found that some plants of *motha* had appeared ; a fresh application of ammonium sulphate was made which effectually eliminated these intruders, and from that date until the time of writing (15th June) nothing but *doob* has grown on these plots, the growth however being perfectly even and close and of dark green colour, and in the case of the sanded plots the surface is hard with no loose matted growth. It would of course have been perfectly easy to have handweeded these plots to remove the intrusive *motha*, but it seemed better to ascertain whether manurial treatment alone could obtain the same result.

The deterioration of the sterilised meal plot was thought to be due to failure in the nitrogen supply and the immediate recovery, visible within 48 hours time, resulting from an application of ammonium sulphate, seemed to prove this conclusively. A further result of the additional treatment has been the rapid extinction of the surviving deep rooted grasses.

It will be seen that this rate of application of ammonium sulphate is an extremely high one as compared with agricultural practice, and is proportionately expensive, the present cost of ammonium sulphate being about Rs. 14 per cwt., but in dealing with such small areas as tennis courts and putting greens this consideration would usually fade into insignificance by comparison with the excellence of the results. It should be emphasized, however, that it would

generally be useless to attempt economy in the use of this treatment as unless enough of the ammonium sulphate is applied the elimination of weeds aimed at will not be obtained.

So far as current expenditure is concerned it is not possible at present to say at what intervals of time it may be necessary to renew the treatment, but so far as experience at Pusa has gone, it does not seem likely that application of ammonium sulphate will be required more than twice in the year and that not at the original rate but at half this quantity, *i.e.*, $1\frac{3}{4}$lbs. in 4 gallons to 100 square feet, say 50lbs. for one tennis court. The necessity for such application can be easily judged by noting the colour of the grass, which should never be allowed to become pale green or yellowish ; should this occur, one application will within 48 hours bring it back to the proper colour. In cases where the presence of an unduly large number or more vigorous growth of weeds occurs it has been found better to apply the ammonium sulphate, at the rate of $3\frac{1}{2}$lbs. to the 100 square feet, in the solid form, sowing it over the ground as evenly as possible and then watering it in with the amount of water (4 gallons) prescribed. The effect is more marked so far as destruction of the weeds is concerned, and might probably be arrived at simply by dissolving the salt in say 3 gallons of water instead of in 4 gallons. It is perhaps advisable here to point out the necessity for avoiding the use of too much water which would destroy the effectiveness of the salt by dilution, and the deleterious effects of irrigating lawns by periodic flooding, which does an immense amount of harm, especially by reducing nitrates and washing down available plant-food from the surface layer where it is wanted by the *doob* to lower levels where it will help the deeper rooted weeds to compete with the former. All water should be applied in small quantities at frequent intervals; every evening during the cold and in the dry hot weather, and during breaks in the rain so soon as drought is indicated by the condition of the grass. The actual amount required is small, just sufficient to moisten the top inch or two in which the *doob* roots are growing.

It was thought that during the drought of the cold weather the deeper rooted plants would have an advantage with regard to

water-supply, but this has not proved to be the case ; the probable reasons for this result are discussed in dealing with the use of sand.

It is perhaps unnecessary to point out that no success will be obtained in growing turf of any kind on waterlogged or sour soil, where an inspection of the grasses will show that nothing but poor acid loving weeds can flourish. On the other hand, the deleterious influence of trees, and more especially of bamboos, is in most cases directly due to their action in absorbing soil water at the expense of the shallow rooted grasses and other plants in their vicinity; this action can be greatly mitigated by cutting deep trenches so as to separate the grass area from the root system of the neighbouring trees, the roots of which must be cut by the trench; care must be taken subsequently to see that fresh tree roots do not grow through the trench as is liable to occur.

Sand.—The soil at Pusa, although of a light sandy character, shrinks on drying, forming a surface crust which interferes with plant growth in various ways, particularly by diminishing the free and even penetration of the soil by water and air, and also by actual mechanical interference with the growth of stems and surface roots such as are formed by *doob* grass, maize, oats, and other plants. In field practice this tendency necessitates surface cultivation, and in the culture of pot plants in the laboratories at Pusa as much as 30 per cent. of sand is added to the soil to prevent the shrinking and cracking of the latter. It has been found by experiment that sand has an advantageous effect on the growth of *doob* grass such as it might have been expected to produce from a knowledge of the above facts in connection with Pusa soil ; it may be stated at once that on soils with any tendencies of the above described character the use of sand is of almost equal importance with that of ammonium sulphate ; *doob* turf can indeed be grown on almost any soil if provided with a sufficiency of nitrogen, but on any of the numerous soils which tend to form a surface crust on drying from a wet condition, it is only by the use of sand that a truly even growth affording a surface, which can be made true by hard rolling and close cutting, can be obtained. The sand combined with a close growth of *doob* roots and stems produces a surface which can be

rolled smooth and hard, however wet it may be, without puddling or forming a crust, the sand moreover provides a surface "mulch" of coarse particles which not only break up and distribute water supplied either artificially or as rain, but prevent drying out of the surface soil during the dry season of the year. It is a remarkable fact that at Pusa the mere application of an inch of river sand to a piece of poor turf resulted in a great improvement not only in the growth of the grasses, but in the general condition of the turf itself by the elimination of the bad weeds. In an experiment in which oil-cake was used by itself and in conjunction with ammonium sulphate a very marked improvement was effected in both cases by a cross dressing of sand, especially in the latter combination. In actual practice the sand does not remain above the soil and separate from it for any length of time, but becomes incorporated with the surface layer, thus rendering it more open in texture and pervious to air, water, and root growth, and it undoubtedly promotes the more rapid nitrification of either oil-cake or ammonium sulphate both by the aeration and even water distribution which it ensures. It will be remembered that the selective action of ammonium sulphate as compared with that of sodium nitrate, in encouraging surface rooting plants, was attributed to its retention near the surface; the change into nitrate which is probably necessary to make it available as plant-food will also be promoted by the aeration afforded by the added sand, also near the surface and therefore more readily obtained by the shallow feeding *doob*. The gradual lowering in concentration of the surface layer of sand by mixture with the soil makes it advisable to repeat the sand application whenever the surface begins to become soft owing to the increasing thickness of the growth of *doob*; in some cases where, owing to richness of the soil, an unduly thick and soft growth of *doob* has formed (as was the case on and around some of the greens, notably the 12th, on the newer part of the Tollygunge golf course) a thick dressing of sand will fill up and harden the turf and allow of the formation of a hard true surface which can be rolled hard and cut close without injury. The most important point in connection with the use of sand is the quality of the latter. It is quite easy to mistake silt

for sand, or to use sand which may be so fine as not to possess the mechanical properties requisite for success. It is difficult to give directions for distinguishing one from the other, but generally speaking it may be said that sand if put in water will sink to the bottom and leave little or no cloudy floating particles and that coarse sand has a very distinct gritty feeling between the fingers. It is of the utmost importance, however, that the material employed should be sand, *i.e.*, particles of quartz, and not silt, which may be a mixture of materials such as felspar, which in course of time will disintegrate to form clay and so produce a worse condition in the surface soil than it may have originally possessed. Building sand, known as "sharp" sand, generally possesses the desirable mechanical properties above described, but it is usually possible to find deposits or pockets of coarse sand in almost any locality. Such sand if thoroughly wetted and compacted should on drying show no tendency to hold together but should fall apart at a touch. As mentioned above, the amount of sand used at Pusa was about 150 lbs. to 100 square feet; for a tennis court this would require about 56 maunds or some 5 cartloads; when first applied most of the grass will be completely buried; the surface should then be rolled smooth and watered with the solution of ammonium sulphate, care being taken to obtain an even distribution of the latter. The ground should be marked out in squares of equal size, the salt weighed out into portions each sufficient for one square and dissolved in the appropriate amounts of water; kerosene oil tins holding 4 gallons can conveniently be used to dissolve 3½ lbs. of the ammonium sulphate, which will then be watered, by a watering pot with a rose, on to one 10 feet × 10 feet square. This can more easily be done by marking out an area 80 feet × 40 feet so as to allow of a margin to a tennis court.

A series of small plots was laid out in which pure cultures of *apang, motha, dabhi, jov* (*Rottboellia sp.*), and *rari* were grown separately in order to observe the effect of varying treatment upon them individually, and to arrive at a more accurate notion of the causes underlying their gradual extinction by treatment resulting in the ultimate production of *doob* turf. These have only been under observation for a few weeks at present, but the addition of sand

has already caused a marked retardation in the growth of all the above mentioned grasses as will be seen from Plate XXXIII. It is not at all clear why this should be so although various conjectures might be hazarded, but the fact remains that sand has a positively prejudicial effect on these undesirables, so far as observation at Pusa has gone, whereas the growth of *doob* is favourably affected.

So far as sand is concerned, therefore, the writer is of opinion that its value for making turf is undoubtedly high for the following reasons :—

(1) It encourages the growth of *doob* and discourages most of the undesirable grasses.

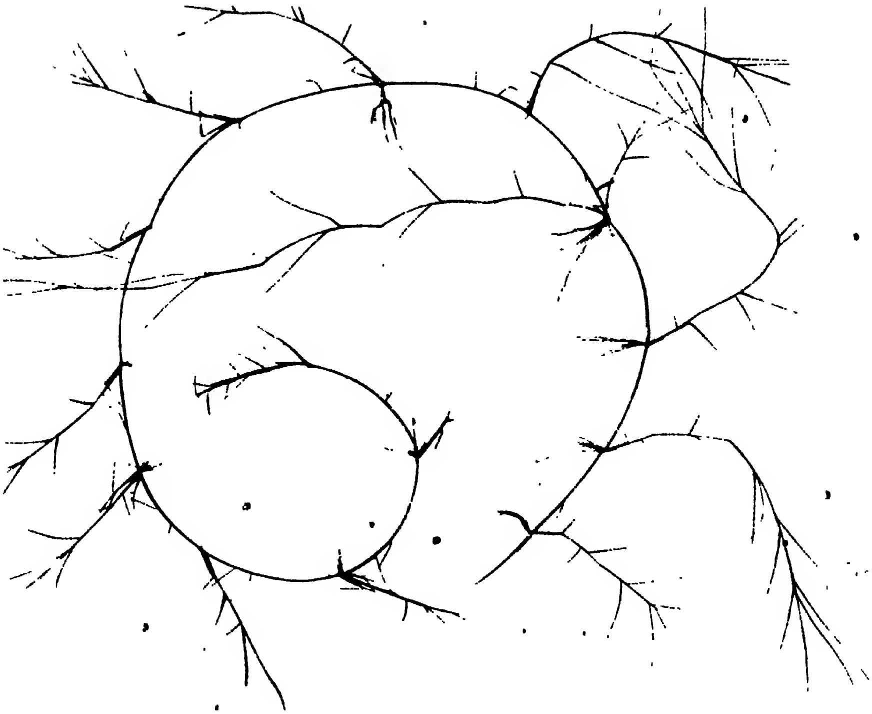
(2) It improves the water-supply, both during the dry season by forming a surface mulch, and during the rains by preventing puddling of the surface and causing even distribution.

(3) It improves the playing qualities of the turf by filling up inequalities, preventing too luxuriant or matted growth of *doob*, and allows of the production of a firm surface by rolling, without the formation of a surface crust.

The method above described of producing *doob* turf depends upon first destroying as much as possible of the undesirable weed growth by heavy dressings of sulphate of ammonia and then upon keeping the surviving *doob* in condition by means of the liberal nitrogen supply thus provided and by the use of sand. The quantities given are those which have proved successful at Pusa, during the dry season, but any reader who wishes to make use of the method is strongly recommended to make his own experimental plots in order to determine the quantities appropriate to the particular soil of his own district. The plots can be quite small, a few feet square, and the quantities varied from half to double that recommended; the sand, however, must be kept up to the amount necessary to cover the surface to a depth of at least one inch. Other alternatives to ammonium sulphate have been tried at Pusa as possibly more readily obtainable, and if used in sufficient quantity and in conjunction with sand have been found successful although not to the same degree, but they were not so easily applied nor was the result so lasting. Sterilised meal has been referred to and the quantity

PLATE XXXIII.

Effect of sand on turf weeds. Left side, sand. Right side, no sand.



Roots of "Doob" (*C. dactylon.*)

used mentioned ; oil cake was also tried successfully, but was much improved by subsequent dressings of ammonium sulphate ; one other method which promises well is now under observation and may be mentioned here as possibly providing a sufficient nitrogenous dressing at only the cost of the labour involved in collecting and applying the material.

The cut grass from a lawn if allowed to lie and not caught in the box on the mowing machine, remains on the surface, where various fates may overtake it ; generally it dries up and gradually falls to powder which resists further decay for considerable periods and merely attracts the attention of insects which feed on it and sometimes turn their attention to the cut ends of the growing *doob* to the great detriment of the latter ; otherwise it may simply blow away as dust or during the rains be washed into unsightly streaks and patches, which then remain moist long enough to ferment and "burn" the *doob ;* this is quite a common effect on lawns mown without a grass box. In either case the manurial effect sometimes attributed to this untidy method does not appear to occur in actual practice. If the cut grass is soaked in water for about a week, the watery extract thus prepared will be found on analysis to contain considerable quantities of ammonia, owing to the fact that the unavailable nitrogen contained in the grass has been brought into this form by such bacterial action as occurs under these conditions ; this ammonia when applied to the soil will perform the same function as sulphate of ammonia although in a different manner, as the browning of the grass plants which is the first visible effect is due to direct poisoning of the latter and not merely to interference with their water requirements by the production of the condition known as "physiological dryness," such as results from the application of sulphate of ammonia. When the *doob* has been established by the use of this grass water, further applications should be considerably diluted and allowed to stand exposed to the air for some days in order to destroy the toxins formed during fermentation which are responsible for the burning effect on the grass. The effects of applications of this extract are not so lasting as those of sulphate of ammonia as they do not contain so much nitrogen in one application,

but it will be obvious that it is only necessary to repeat them at the proper intervals in order to maintain the necessary supply of nitrogen. It will perhaps make the matter clearer if it is pointed out that *doob*, as above-mentioned, depends upon a liberal supply of easily assimilable nitrogen, and that the ordinary processes of decay of organic matter in the soil do not as a rule provide this with sufficient rapidity nor near enough to the surface; for the same reason cut grass left lying will fail to supply nitrogen because it tends to decay in such a manner that its nitrogen remains inert ; if however it is brought under the conditions above described the special bacterial action involved will ensure the inclusion of the nitrogen it contains in the process of decay, with the result that this necessary element is brought into an available condition at a rapid rate.

It is unfortunate that the grass water thus prepared possesses a characteristic odour which is not altogether desirable ; this may be mitigated by exposure to the air, and when the water is to be used in conjunction with sand the latter may be made into a heap and watered with the extract previous to application ; this will reduce the odour considerably. Experiments are in progress to determine a method of destroying it altogether without loss of ammonia ; a solution of permanganate of potash is the simplest and most effectual means so far discovered. It may be mentioned that the decomposing grass continues to give up ammonia for a considerable period, so that several fresh water extracts can be made from the same material. The remaining decomposed grass itself may be advantageously used in place of cattle manure in the garden.

Although experience has shown that the artificial supply of nitrogen will suffice to produce a luxuriant growth of *doob* on a soil which without this addition appears too poor to carry it, it must be remembered that this crop, like all others, requires in addition such elements as phosphorus, potash, and lime ; some soils may be so poor that no amount of nitrogen alone will produce growth, and in such cases it will be necessary to use a more complete manure, and indeed in any case the luxuriant crop produced by the use of ammonium sulphate will eventually deplete the soil and make it necessary to restore the loss. This might be done so far as phos-

phate, potash and lime, are concerned by the method of leaving the cut grass lying on the surface, but, as has already been pointed out, the manurial action of such treatment is irregular and the nitrogenous portion does not come into full use. Two methods may be adopted; in one the original laying of the lawn will include the importation of good soil to form a basis for growth; in the other the use of such a manure as sterilized animal meal or oil-cake will provide the necessary phosphates together with nitrogen. The selection of method will depend naturally upon local conditions. In the case of the animal meal this manure contains a high percentage of nitrogen and phosphates and has given excellent results as detailed above. On the other hand, a 4-inch layer of good loam in conjunction with a top dressing of sand and sulphate of ammonia has produced equally good results although with less rapidity.

Cricket Grounds.—As above pointed out different treatment is required for the preparation of the wicket-table and of the out-field. In the former for instance the use of sand is not permissible as this produces a wicket which rapidly goes to pieces and becomes dangerous; in this case if the soil is light and sandy, it is necessary to import a heavier variety of soil which will roll out into a good wicket *doob* can be grown on this by application of ammonium sulphate and careful handweeding, and as it will only be used in the cold weather, much less trouble will be experienced in keeping it in condition than would be required during the rains; this refers to the use of a heavy soil upon which *doob* will not do well if cutting and rolling are carried out to any extent in wet weather. It must be remembered, however, that a cricket pitch requires only a minimum of grass, just sufficient to keep the surface together but not enough to produce a dead wicket. Where a wicket-table has been built up by importing soil, it will often be found that the grasses deteriorate after a few seasons owing to the appearance of weeds such as *motha* and *dabhi;* this generally means that the immediate surface layer upon which the *doob* depends for food has become depleted either of nitrogen, or phosphates, potash and lime, or sometimes of all four; the first of these is generally the limiting factor, but when ammonium sulphate fails to produce a response it is in consequence of depletion

of one or all of the last three. A general manuring is then indicated, but if the condition of affairs is really bad it would be better to plough up the affected area at the beginning of the hot weather in order to get rid of the weeds and their roots by drying them out. Otherwise a dressing of sterilized animal meal at the rate of 10lbs. to 100 square feet will be found effective, or, if the deterioration is taken at an early stage, a simple dressing of good loam soil, dried and sifted, will carry on the growth of *doob*, although it may be necessary to supplement it with sulphate of ammonia within a few weeks of application.

Cutting and Rolling.—It is a matter of common knowledge that good turf can be produced in time simply by judicious cutting and rolling of a mixture of good and bad grasses, provided that moisture and soil conditions are sufficiently good to support growth. The selective action of these two operations, so far as *doob* and other grasses are concerned, appears to depend upon the following points. Repeated cutting close to the ground puts a strain upon the coarse grasses by making it necessary for them continually to produce fresh leaves to take the place of those removed ; a similar strain falls upon the *doob* but owing to its habit of growth, which is close to the ground, the mowing machine removes a much smaller proportion of leaf, and the adventitious roots which occur at frequent intervals along the stem help to provide nourishment and water to every part of the plant and make it independent of the main root from which it started growth. In the same way other fine-leaved grasses will survive cutting which is too close for the coarser kinds, this action being largely responsible for the production of turf where other grasses than *doob* are concerned. Cutting may be regarded as a form of pruning the grass plant and has the effect of stimulating growth indirectly and altering its character and the shape of the plant itself, the general effect being the production of a larger number of leaves and stems over the same area of ground and consequently a thicker and closer turf. It is therefore of great importance that this operation should be carried out systematically and with judgment, both with regard to the height of the cut above the ground and the frequency of cutting. With reference to the latter point it

should be observed that too long intervals between cuttings, especially with lawns formed of other grasses than *doob*, can ruin turf more surely than almost any other method ; the immediate result of such unduly long intervals is to allow the formation of stems and leaves which are not only long but thick, these when cut remaining as stubble amongst the surrounding growth and giving occasion for more regrettable expressions upon the putting green than any other agency outside the match. Good turf must be cut before it gets to this stage, and at the same time must be provided with the extra nutriment required by the increased growth resulting from the stimulus of cutting.

It will be seen that cutting means more than simply preventing the grass from getting too long, and for this reason it is important to make use of an efficient machine, which will not only cut as close as may be found necessary, but will withstand the efforts of the *mali* to bring about its disruption. Cheap machines have defects which in the writer's opinion more than counterbalance their cheapness, and where it is desired to cut comparatively small areas of turf and at the same time to produce a good playing surface they cannot compete with high class machines. If it is merely a question of keeping down jungle and giving a general impression of upkeep by haggling off the ends of the grass with blunt ill-adjusted cutters, then cheap machines are as good as more expensive ones. but owing to various defects in material and design inseparable from their lower price, it is impossible to keep them in first class cutting condition, nor can they. even when new, cut as close or even as a good machine ; this is a question of gear ratio. and number of knives in the revolving cutter, which varies from three in cheap machines to six in good makes, just as the wearing is one of accurate machining of the gears and of the material used in them and in the bearings. The point to be remembered is that judgment must be exercised in setting the height of the cutter-bar above the ground so that the requisite amount of grass may be cut, but that this will be wasted if the machine used cuts unevenly, or if the cut is not clean either on account of a too low gear ratio or because the cutter-bar or knives are not properly set, so that the grass is half pinched and half pulled off ; this has a very bad effect on *doob* especially during dry weather as the pull

destroys the attachment of many young adventitious roots to the ground and leaves them to dry up; this effect can be seen quite easily on examination of turf cut with a blunt slow-running mower. The best size of machine to employ for small areas depends upon the character of the surface; if this is dead level, as on a tennis court, the use of a comparatively long cut, such as 20 inches, will cover the required area in less time and with equally good results; but on putting greens where hollows and small curves may occur, a 12-inch cut will be found more suitable; the larger machine has an advantage in weight, inasmuch as it will run nearer the ground and also perform the function of a roller; on the other hand, during wet weather, a light machine may be used with impunity when a heavier one may damage the surface; a sufficiency of sand will, however, minimise this drawback. With regard to rolling it may be pointed out that on a *doob* lawn one of the functions of the roller is to bring the *doob* stems into sufficiently close contact with the ground to promote the formation of adventitious roots at frequent intervals.

It should be unnecessary to point out the fatal effects of either rolling or cutting turf when the latter is too wet; the obvious results of such action are rapid deterioration in the quality of the growth, frequently accompanied by discoloration and death of the grass plants; the extent to which these effects will follow depending upon the character of the soil and the amount of moisture present at the time. It does not require much knowledge of the conditions of growth to enable one to understand how this comes about, as it is obvious that the weight of the roller or mower will puddle the soil surface if wet enough, and probably bury the growing points of the grass; at the same time the puddling will result in the formation of a hard impervious crust which will choke the plants.

A word of warning may be given with reference to worm-killers; which are frequently used without any consideration of their effect upon the turf grasses, or of the fact that the destruction of earthworms may save trouble for the green keeper, but at the same time removes the only means of aerating the soil under the turf. Some worm-killers contain salts of lime which frequently produce a per-

manent greasy, moist condition, especially in badly drained turf, and in most cases promote the growth of clovers which should of course be avoided at all costs. Others are acid in character, and if used too freely may reduce the lime content of the surface soil so as to interfere with nitrification.

A solution of corrosive sublimate of 1 in 1,000 has been found effective, but its poisonous properties make it a dangerous substance to place in the hands of the Indian *mali*.

Worm-killers therefore should be employed with great caution, and more especially on turf which has any tendency to become waterlogged, as worm burrows exercise a highly favourable influence upon the surface drainage and aeration of the soil.

It may be pointed out that much harm may be done by rolling in wet worm casts, each of which when flattened out tends to smother the grass under it and produce a bare patch.

Since writing the above it has been found that the selective action of ammonium sulphate upon a mixture of turf grasses, which occurs in the cold weather, and its stimulative effect upon *doob* are very considerably modified during the rains, as soon as the soil becomes sufficiently moist to prevent the necessary concentration of the salt in the top layers, and to produce vigorous growth of the weeds. It is therefore advisable to make use of the method recommended above during the cold weather, although there is no reason why ammonium sulphate and sand, especially the latter, should not be used with advantage to improve the condition of turf during the rains; it is an interesting fact that the obvious improvement in the colour of the grass which follows an application of ammonium sulphate within 48 hours in the dry weather, does not at Pusa make its appearance sometimes for a week or ten days during the rains. This is a question of soil temperature and loss of nitrate by reduction and leaching which is of great scientific interest but will be reserved for publication with a more appropriate context.

In conclusion, it may be said that the study of turf formation under varying conditions of treatment may be made of great interest by any one possessing a few square yards of ground, a fair supply of water, and sufficient interest in the subject.

INVESTIGATIONS ON PAPAYA.

BY

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"*Carica Papaya.* The Papaw.—This well known tree has been subjected to ill-merited abuse, described as ugly and everything that is disagreeable, yet it may be questioned if there is a more handsome or generally useful tree in Indian gardens."—(WOODROW.)

Propagation.

Cuttings.—The only method by which the papaya has so far been propagated is from seeds. Experiments made in the Ganeshkhind Botanical Gardens, Poona, show that vegetative propagation by cuttings and by grafting is possible. The first experiments were made with 5 plants about a foot long which after being transplanted in July, 1913, became rotten below ground level owing to the excessive rains of August. These were uprooted and the rotten portion removed, the upper portions being then planted in a pot and placed in a hot frame. Of these, one struck roots in a month and was transplanted outside, but soon died of exposure. After this about a dozen cuttings from fresh wood were taken and in January, 1914, were planted in the ground, under shade, and treated as usual along with other cuttings. The result was that the cuttings grew pale and rotted below ground. Another attempt was then made in February, 1914, with two dozen cuttings each about one foot long and ½ inch thick, taken from one-year-old wood of a country variety. One dozen cuttings in pots were placed in hot frames

and the other dozen in the ground, under shade. This time the treatment was different. Sand only was used both in pots and outside as a substratum for planting the cuttings. Of those outside, five rotted despite the care taken in watering. Those in the hot frame kept in excellent condition and only one of them died. They produced new leaves in a month while those in the ground were found to be slower in growth.

Grafting.—In January, 1914, 5 male plants just flowering were whip-grafted with scions of the andromonœceous type (plants with male and perfect flowers on same trees). The thickness of the scion was equal to that of the stock, *i.e.*, half an inch. Three of these died and the other two produced new leaves in a month and remained healthy until April, 1914, when one was attacked by insects and the leaves eaten; this graft succumbing in consequence. The second one is now in good condition with new green leaves. The importance of these results lies chiefly in the fact that it may be possible by using these vegetative means of reproduction to settle conclusively some of the questions regarding the inheritance of sex in the papayas. It is doubtful as yet whether they will be of any special value in the practical cultivation of the plant.

Branching of Papaya.

Papaya has a supple, thin, straight trunk branching only when its growth is interfered with. When cultivated it attains the height of from 12 to 20 feet. On account of its considerable height difficulties arise in watching and gathering the fruit. The stems are also easily damaged by wind.

To remove these difficulties, experiments were made in the Ganeshkhind Botanical Gardens, Poona, to encourage branching by the removal of tops of the stems about the time of flowering. Accordingly 10 plants were selected in August, 1910, and the tops of five removed to encourage branching. In a fortnight five to six shoots were produced below the wound, only two being encouraged in each case. Fruits were harvested from December, 1912, to the end of March, 1914. No fruits were obtained from July

to December, 1913. The following table shows the outturn of fruits in branched and unbranched plants :—

Branched.			Unbranched.		
Plant.	No. of fruits.	Average weight in ozs. of each fruit.	Plant.	No. of fruits.	Average weight in ozs. of each fruit.
1	45	56·8	1	19	33·0
2	32	42·0	2	16	28·2
3	30	26·6	3	21	33·7
4	61	45·9	4	31	58·7
5	23	32·0	5	28	66·2
	Total 191	203·3		115	219·8
	Average 38·2	40·65		23·0	43·96

The above table shows that the branched plants gave a greater average number of fruits which were of slightly less average weight. It was observed that the branched plants were less frequently damaged by winds, and the fruit was easy to watch and to harvest. In these circumstances it may be said that the system of branching, if done carefully so as to admit air and light and at the same time to break the force of the wind, will prove most beneficial. In June, 1913, one more plant was operated on with special care. In this case four branches were encouraged, one to each point of the compass. The fruits on each branch were uniform in size and shape and also bigger than the average fruit of other plants. (*See* Fig. 2, Plate XXXIV.)

It may be noted in passing that Mr. F. B. Kilmer in his article on "The Story of Papaya"* states that removing the top of the plant and thereby encouraging more branches and fruit is much more beneficial in cold climates since the plant is protected from frost, and fruit is produced near the ground.

It is also mentioned in *Hawaii Agricultural Experiment Station Report* for 1911, page 30, that to get large sized fruits, it is best to prune off the branches when they first appear.

* *Jamaica Agricultural Department Bulletin*, Vol. I, Part 8.

E XXX

Thinning of Papaya Fruits.

The fruits of the papaya are borne round the stem in such a way that they interfere seriously with each other's growth. It is therefore best to remove a certain number of fruits to allow the rest to develop better.

With this end in view 10 plants in the Ganeshkhind Gardens, Poona, were operated on in September, 1910, one unthinned plant being left for control. The process caused much greater development of the individual fruits (*See* Fig. 1, Plate XXXIV), one being as heavy as 8lbs., and the remainder ranging from 6 to 8lbs. A dealer offered 4 annas each for the thinned fruits. The unthinned tree had many fruits which had crowded and deformed one another. A similar experiment was tried under the writer's advice in a cultivator's field and the results were equally satisfactory.

In 1912 the experiment was again systematically conducted in the Ganeshkhind Gardens, Poona, twenty plants being selected and labelled A and B. The 10 plants labelled 'A' were thinned and the 10 plants labelled 'B' were left unthinned as controls. The variety used was Ceylon. The following table will show that the average number of fruits from the thinned plants is much less than that of the unthinned, but the average weight is correspondingly greater. The estimate of the money value is based on a small number of fruits only which, when sent to the market, brought the following prices:—

Thinned.				Unthinned.				Remarks.
No. of fruits.	Price.			No. of fruits.	Price.			
	Rs.	As.	P.		Rs.	As.	P.	
4	0	5	0	3	0	2	9	
6	0	3	6	16	0	13	0	
..	..	..	..	5	0	3	0	
10	0	8	6	24	1	2	9	
The average price per fruit comes to 10·2 pies.				The average price per fruit is 9·3 pies.				

A. Thinned.				B. Unthinned.		
Plants.	No. of fruits removed.	Fruits obtained.	Average weight of each fruit in ozs.	Plants.	Fruits obtained.	Average weight in ozs.
1	12	6	39·3	1	20	37·2
2	15	11	34·0	2	23	31·5
3	16	7	48·2	3	11	30·5
4	16	8	54·0	4	15	35·8
5	23	9	47·7	5	14	36·1
6	10	7	43·0	6	14	38·7
7	11	6	36·8	7	15	36·4
8	7	1	27·0	8	28	26·9
9	5	4	42·0	9	11	30·8
10	13	10	37·7	10	11	24·3
Average ..	12·8	6·9	40·9		16·2	32·8

The above results show that the increase of weight is not sufficient to compensate for the loss of fruits in the experiment under consideration. Another experiment gave the following results :—

Plant.	Fruits removed.	Fruits obtained	Weight.
1	5	3	71·6 ozs.
2	6	7	65·0 „
3	7	3	52·3 „

Here the weights are greater but the fruits still fewer.

With a small number of, say, six good fruits per plant the experiment may pay ultimately when run on a large scale. *vide* the *Annual Report of the Government Horticultural Gardens, Lucknow,* for 1912, where it is stated that an acre of land carrying 1,000 plants, each producing 6 to 10 fruits after thinning may give considerable profit to the grower. The difficulty is to hit on exactly the right amount of thinning to get the greatest weight compatible with the greatest number of fruits. This can only be obtained by practice and in the meantime it is recommended to remove only such fruits as are obviously going to be badly crushed.

NOTES

STIMULATED by the accounts of the successful use made of prickly pear for feeding animals, which appeared in a recent number* of the Journal, the present writer has been making a few desultory trials, following the suggestions therein laid down. He was unable to buy an "Effective" Stove, and had to be content with an ordinary Primus Stove, costing, delivered at Coimbatore, Rs. 9-4-0.

The authors lay great stress on the careful burning of the spines, but do not in the writer's opinion sufficiently emphasize the difficulty of doing this.

It was found on trial that a most prolonged toasting was necessary to get rid of the bunches of "hairs": it was easy enough to singe the tips, when their unpleasantness was largely alleviated (owing no doubt to the destruction of the 'barbs'), but the 'hairs' themselves persisted in thick tufts and could not be entirely destroyed.

Perhaps some of the readers of this Journal could give the results of their own trials and say with what success they have followed the instructions laid down. The matter is important, because the difficulty of utilising this fodder supply is just what makes it such a valuable reserve in times of scarcity.—(R. CECIL WOOD.)

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IN the *Indian Trade Journal* for July 23rd, 1914, there is an interesting note on the efficiency of "the small top milk pail," an American invention of quite recent date, for keeping milk in the pail free from dirt.

The invention consists of an ordinary pail to which is fitted a cover having a small aperture in it on the side furthest from the

* The *Agri. Jour. of India*, Vol. IX, Pt. II, April, 1914

milker. It has been found that by the use of this simple invention 97 per cent. of the bacteria usually present were kept out, when this pail was used in cowsheds which were not well kept. While under better conditions the milk drawn in the open pail was found to contain $6\frac{1}{2}$ times as many organisms as that collected in the small top pail.

This gives a startling proof of the extraordinary efficiency of this simple appliance—but it is to be strongly urged on all farmers and milkmen that the use of such appliances, effective though they may be, does not render the user free to dispense with the three essential operations to be performed before milking—1 grooming the cow; 2 washing the udder and teats; 3 washing the hands. The small top pail will help those who try to keep their milk clean, but it will not enable the deliberately filthy (the Indian milkman comes under this heading) to continue in his objectionable ways without affecting the milk, and it cannot be too strongly emphasized that none of these inventions will render such operations as milking a cow with a dirty udder into a half-washed pail with a filthy pair of hands, anything but criminal negligence.—(W. SAYER.)

* * *

IN the April (1914) number of the *Monthly Bulletin of Agricultural Intelligence and Plant Diseases*, Rome, there is an interesting article by Mr. D. L. Simois (Director of the National School of Agriculture and of Sugar-making at Tucuman, Argentina), on the cultivation of sugar-cane in the Argentine Republic. In it he traces the history of the cultivation of sugar-cane in Argentina from the beginning of the seventeenth century up to 1767 when with the expulsion of the Jesuits the manufacturing of sugar ceased for fifty-four years.

In 1851 the industry was revived by Dr. Colombres, and after several vicissitudes it has reached a stage in 1914, which is best expressed by the simple statement that about 14 millions sterling is now invested in the sugar industry in the Argentine. The area under cane is about 250,770 acres (by Argentine statistics which are not very exact), and of this area the province of Tucuman lays claim to 220,000 acres. It will thus be seen that nearly all the facts

mentioned by the author in his article apply to Tucuman province and not to Argentina as a whole.

The soils on which cane is grown are two in number: (*a*) Loams having up to 90 per cent. of clay most of which is very fine. It is only possible to grow cane on these soils by means of irrigation; (*b*) Humous sands, which have been recently cleared of forests, and still retain much moisture.

Artificials are not generally used, principally for economical reasons. The soils noted above are fertile but deficient in lime, which rarely reaches one per cent. Potash is in excess and Nitrogen and P_2O_5 about normal.

The greater portion of the area is under two varieties of cane: the brown *Morada* (which is in the majority) and the striped *Rayada*—both of which were introduced many years ago. They are, however, considered local varieties as they have developed special characteristics which effectually disguise their origin.

The "Escuela Nacional de Agricultura y Sacarotecnia" of Tucuman is experimenting largely on the cultivation of foreign varieties, and at present has upwards of 250 groups under observation.

Only one system of planting is followed in the Argentine, the cane cuttings, each with three or four eyes, are placed in a continuous series in the bottom of a furrow, which is 8 or 10 inches deep. The rows are from 6 feet to 6 feet 8 inches apart.

The plantation is renewed every 6 or 7 years according to the quality of the soil. Plantations made in September or October are cropped in June or July of the following year, that is at 9 or 10 months old.

Barely a third of the acreage under cane in Tucuman is irrigated, but, even in the localities where irrigation water is available, it is quite exceptional to find estates which irrigate systematically and drain in a suitable manner. Thus it is not rare to find irrigation more injurious than beneficial.

The average yields of cane per acre are as follows:—

Bad years	6¼ to 8 tons per acre.
Normal „	9 to 10½ „
Good „	11 to 14 „
Very good years	16 to 20 „

This gives a range of from 6½ tons to 20 tons per acre. The cost of production is from 8*s*. 6*d*. to 12*s*. 6*d*. per ton of cane, and the sale price varies from 19*s*. 6*d*. to 25*s*. There are at present 38 sugar factories in Argentina of which 28 are in Tucuman.

Owing to the improvement of the machinery the amount of sugar extracted from the cane as delivered at the factory has risen from 3lbs. sugar per 100lbs. cane in 1870 up to an average yield of above 9·5 lbs. sugar per 100lbs. cane, which was obtained by the most modern mills in 1913.

It is noteworthy that the experimental station referred to above has opened a small sugar factory of its own, capable of crushing 30 tons of cane per day, and this should, by its practical demonstration in the hands of experts, assist greatly in the further improvement of the methods of sugar-making.

Foreign refined sugar pays 1¾*d*. per lb. duty, which will be lowered to 1½*d*. per lb. in 1921, by which time the local industry should be able to fend for itself.

There are at present only four sugar refineries in the country, but others are being built. and everything seems to point to a thriving and profitable industry on a large scale in the near future.—(W. SAYER.)

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The Agricultural News of the West Indies, reports the successful experiment, by the Agricultural Department, of sending cane cuttings in damp charcoal (1lb. charcoal, 4oz. of water) to India by parcel post, thereby lessening the time and the consequent risk in the usual method of transportation by ship. As the maximum weight allowed for sending by parcel post is 11lbs. special tins were constructed, and the size of the cane cuttings was reduced to a minimum. The light tins employed measured 18 inches × 4 inches × 4 inches, and cuttings were selected, having the nodes moderately close together, thereby getting a good number of buds per cutting with a minimum bulk of cane.

The time taken during the transportation was only six weeks. On its arrival in India, the case of cuttings was opened immediately. Many of the buds were found to have already sprouted, the sprouts

varying from ½ inch to 2 or 3 inches in length. In a few cases rootlets had developed 1 to 2 inches long. These looked in perfect condition and were unbroken and undamaged. The canes themselves were perfectly healthy in appearance, not in the least dried or shrivelled up, quite hard, and bright in colour.

The cuttings were planted out at once, and it is reported by the Agricultural Chemist, Assam, that they had all germinated and were doing well.

The trial was reciprocated in India by forwarding cuttings of Dacca *ganderi* by the same method to the West Indies where the parcel is reported to have been received in good condition.—(EDITOR.)

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THE steadily rising prices of bullocks and of agricultural produce enhance the interest of an article on Power Pumping in the May (1914) number of *The Indian Agricultural World*, by Mr. W. M. Schutte, Engineer of the Bombay Agricultural Department.

Mr. Schutte, who has had 15 years' experience of pumping work compares the annual expenses of lifting water for the irrigation of from 15 to 20 acres, from heights of from 30 to 45 feet, in various districts in Bombay, by mhotes and by centrifugal pumps respectively—the figures being taken from plants actually at work on cultivators' lands. The average cost works out at something less than half in the case of the centrifugal pump, being very much less in every instance.

The remainder of the article is devoted to a short but useful discussion of some of the advantages and disadvantages of various types of prime mover—including engines driven by steam, crude oil, paraffin, petrol, gas, and suction gas. The cultivators of the Bombay Presidency are lucky in being able to avail themselves of the services of a consulting engineer for this class of work.

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OF recent years there has been a steady increase in the export to foreign countries of some of the important manures produced in India, such as bones, oil cakes, fish guano, etc., which indicates

that Indian cultivators have not yet fully realised the value of the application of such manures to their land. Owing to religious scruples bones are not used to any large extent but in some places their application has resulted in increased outturn, especially for the paddy crop in parts of Bengal and Assam, and there seems to be every probability of their use being extended in these parts.

Oil cake constitutes one of the most important organic nitrogenous manures available in India, but its use is confined to a limited extent, its value is however fully appreciated in certain Districts such as Poona and Assam, and the experience of such places should be useful in introducing its use into similar localities.

The following figures of export are for the last three years and have been taken from Part II (1914) of the *Quarterly Journal of the Indian Tea Association* :—

Statement showing the quantity and value of different kinds of manures exported from India to different countries during 1910-11, 1911-12, *and* 1912-13.

	BONES.					
	QUANTITY—TONS.			VALUE—IN STERLING.		
Exported to	1910-11.	1911-12.	1912-13.	1910-11.	1911-12.	1912-13.
	Tons.	Tons.	Tons.	£	£	£
United Kingdom ..	14,056	13,269	15,454	59,958	62,085	74,843
Ceylon	6,482	8,648	8,781	21,676	32,061	32.739
Straits Settlements (including Labuan) ..	45	5	81	113	22	423
Hongkong ..	2,661	758	15	12,312	3,531	85
Natal	825	750	300	3,467	3,750	1,436
Western Australia ..	30	..	..	..	..	..
New Zealand ..	7,310	4,002	3,739	34,127	20,201	19,602
Other British Possessions	..	7	..	..	30	..
Germany ..	9,952	9,553	13,006	44,526	47,604	65,627
Holland	400	..	..	1,785	..	..
Belgium	23,262	29,894	33,822	101,940	137,803	159,332
France	13,249	13,419	17,089	57.833	62,289	81,788
Austria-Hungary ..	..	10	441	..	33	2,297
Japan	4,659	6,247	9,170	20,533	29,431	46,609
U.S.A. Atlantic Coast	750	400	2,927	3,299	2,000	14,171
U.S.A. Pacific Coast		1,400	4,834		3,860	24,031
Sandwich Islands ..	..	600	550	..	2,020	2,693
Other Foreign Countries	1	1	12	5	3	63
TOTAL ..	Tons 83,682	88,963	110,221	£361,694	410,623	525,739

FISH MANURES AND GUANO.

Exported to	Quantity—Tons.			Value—in Sterling.		
	1910-11.	1911-12.	1912-13.	1910-11.	1911-12.	1912-13.
	Tons.	Tons.	Tons.	£	£	£
Ceylon	14,161	14,629	17,885	42,652	45,290	53,429
Straits Settlements (including Labuan) ..	2,192	3,157	3,242	8,967	12,780	14,464
Hongkong ..	92	176	31	434	1,272	187
Zanzibar and Pemba ..	105	..	2	700	..	5
Germany	..	555	112	..	2,417	667
Japan	22	106	136	115	391	662
German East Africa ..	37	..	..	250	..	..
Total ..	Tons 16,609	18,623	21,408	£53,118	62,150	69,414

OTHER KINDS.

Exported to	Quantity—Tons.			Value—in Sterling.		
	1910-11.	1911-12.	1912-13.	1910-11.	1911-12.	1912-13.
	Tons.	Tons.	Tons.	£	£	£
United Kingdom ..	369	404	1,370	2,500	2,810	6.922
Aden and Dependencies	5	49	26	35	420	20[illegible]
Ceylon	902	682	2,543	5,352	5,241	11,99[illegible]
Straits Settlements (including Labuan)..	419	344	17	3,590	2,388	17[illegible]
Other British Possessions	..	..	27	..	..	5[illegible]
Germany	950	895	916	5,384	4,996	4,43[illegible]
France	..	18	140	..	99	887
Austria-Hungary ..	..	26	188	..	170	75[illegible]
Native States in Arabia other than Maskat Territory and Trucial Oman	1	13	11	4	115	94
Japan	224	305	586	1,956	1,204	2,97[illegible]
U.S.A. Atlantic Coast	967	1,373	2,500	8,106	11,353	22,30[illegible]
U.S.A. Pacific Coast		191	..		1,780	
Other Foreign Countries	15	6	14	73	53	91
Total ..	Tons 3,852	4,306	8,338	£27,000	30,629	50.89[illegible]

OIL CAKES (ALL KINDS).

Exported to	Quantity—Tons.			Value—in Sterling.		
	1910-11.	1911-12.	1912-13.	1910-11.	1911-12.	1912-13.
	Tons.	Tons.	Tons.	£	£	£
United Kingdom ..	627,585	740,187	933,805	149,650	177,957	226,898
Ceylon	944,688	856,685	964,723	243,157	250,285	292,826
Straits Settlements (including Labuan)..	64,670	35,955	46,241	15,021	8,138	11,648
Hongkong.. ..	20,602	13,336	41	3,916	2,243	8
Mauritius and Dependencies	100	..	..	29	..	..
Other British Possessions	100	371	258	33	73	53
Germany	293,420	548,914	501,563	77,539	140,381	130,381
Holland	..	2,001	9,823	..	642	3,542
Belgium	2,000	5,008	..	400	1,058	..
France	2,380	2,995	..	678	840	..
Java	25,800	8,820	20,692	6,820	1,984	5,457
Indo-China (including Cochin China, Cambodia, Annam and Tonkin) ..	15,900	23,440	12,603	3,737	4,918	2,533
China (exclusive of Hongkong and Macao)	..	24,258	9,155	..	3,842	1,583
Japan	297,576	502,468	736,786	58,606	98,559	146,453
Other Foreign Countries	35	..	13	8	..	5
Total ..	Tons 2,294,856	2,764,438	3,235,703	£559,594	690,920	821,387

TOTAL (ALL MANURES).

Kind.	Quantity—Tons.			Value—in Sterling.		
	1910-11.	1911-12.	1912-13.	1910-11.	1911-12.	1912-13.
	Tons.	Tons.	Tons.	£	£	£
Animal Bones ..	83,682	88,963	110,221	361,694	410,623	525,739
Fish Manure ..	16,421	18,356	21,408	52,208	60,959	69,414
Guano	188	267		910	1,191	
* Oil cake (all kinds including manures) ..	55,516	59,799	3,235,703	244,319	270,989	821,387
Other kinds	3,852	4,306	8,338	27,000	30,629	50,890
Total	Tons 159,659	171,691	3,375,670	£686,131	774,391	1,467,430

* The figures for 1910-11 and 1911-12 represent exports of "Oil cake (manure)," while those for 1912-13 represent "Oil cake (all kinds including manures).—(Editor.)

REVIEWS

TUBE WELLS—BORING, SINKING, AND WORKING.—By T. A. MILLER BROWNLIE, C.E. Second Edition (obtainable from Messrs. Thacker, Spink & Co., Calcutta). Price, Rs. 5.

THE chief aim of this little book is to describe various methods of boring and pumping systems, which may be adopted to suit the convoluted Tube Well.

The well of this type designed by the author was described in Vol. VIII, Part II, of this Journal. Should the type prove with continuous working to yield the results claimed by the author, there is no doubt that there is an important future before it for irrigation purposes—perhaps more particularly in the more recent alluvial soils where the open tube type of well is rarely a success owing to the difficulty of finding a '*mota*' or clay bed sufficiently strong to support the overlying strata over an actual cavity in the water-bearing stratum.

While there are other types of tube well in the market, and only time can show which is the best for any given set of local conditions, none of the older types have yet proved in the long run entirely satisfactory and this book should be a useful incentive to the more general trial of the type invented by the author.

We would, however, add a word of caution. The book is written by an Engineer for Engineers, and those who are not Engineers by profession should not be misled, by the apparent ease of manipulation of the various plants described, into undertaking boring or pumping operations without professional assistance.—(A. C. D.)

THE ANNALS OF APPLIED BIOLOGY, Vol. I, No. 1; pages 1—106, 8 plates and 14 text-figures; Cambridge University Press. Price, 7/6 nett.

THIS new magazine, to adopt the words of the editorial preface, "is intended to cover the ground in applied biology which is not now covered by special journals." It seems difficult to imagine any branch of biology, applied or not, which is not already provided with literary channels—there are, for instance, upwards of two thousand periodicals which may contain articles dealing with entomology—and fresh additions to the lengthy list can hardly be hailed with joy by the ordinary worker who has to extract and record the various papers contained in them. However, each new venture must be taken on its merits and these will doubtless determine its success or failure.

The "Annals" open with an article by Professor F. W. Gamble on "Impending Developments in Agricultural Zoology," which notes briefly recent progress in the Fauna of the soil as regards Protozoa, Nematodes, Earthworms, and the Parasitic Helminths. The following sentences are extracted from the concluding paragraph :—"We need a careful census of the country, a census that is of the animals and the animal-borne diseases affecting agriculture. We need more work, far more work, on the life-histories of the groups in question, whether indifferent, noxious, or beneficial." These words are apparently intended to apply especially to conditions in England but might well be used, still more forcibly, of India.

It is impossible to notice all of the nine papers contained in this number. An article by R. H. Deakin on Power-Spraying of Oak-trees in Richmond Park contains five plates which show the apparatus employed. On page 79 occurs a statement that "*Gypnosoma dealbana* Frol., I am told, has not previously been recorded from the oak;" a reference to Meyrick's excellent Handbook, or even to Stainton's obsolete manual, would have rectified this impression, whilst Frolich's original description of the species records it as "in quercu."

An excellent and clearly-written article by E. E. Green on the preparation of scale-insects for microscopical study concludes the first number of the Annals, to which we wish every success.—(T. B. F.)

Crop-Pest Handbook for Bihar and Orissa (including also Western Bengal). (Pages 1-xxiii + 1-141 and 55 Plates.) (Messrs. Thacker, Spink & Co.) Price, Rs. 4.

This Handbook has been compiled by Messrs. S. K. Basu and H. L. Dutt, Assistant Professors of Mycology and Entomology at the Agricultural College at Sabour, under the direction and supervision of Mr. E. J. Woodhouse, Economic Botanist to the Government of Bihar and Orissa. It was fully completed and should have been issued two years ago—it may be noted, by the way, that the date of publication as given on the title-page is incorrect, the book not having been issued until June 1914—but publication was delayed owing, we are told, to "difficulties in obtaining funds due to the re-partition of Bengal."

The book is a collection of eighty-four leaflets on the more commonly occurring pests and diseases of crop-plants: only the former are dealt with in this review. These are noticed under the headings of Names, Nature of Damage, Locality and Time of Appearance, Foodplants, Description and Life-history, Enemies, Remedies, and References to previously published literature of the Agricultural Department. The illustrations comprise fifty-five Plates of which forty-five are coloured and nearly all of these represent insects, but most of the uncoloured Plates would better have been described as text-figures (*e.g.*, "Plates" XIX and XX). Each of the leaflets which compose the book is paged separately: so far as the bound volume is concerned it would have made for convenience if the pages had also been numbered consecutively; this procedure would have allowed more ready reference by means of the Index of Plants and that of Pests, both of which might have been made rather more complete.

As regards the plan of the work, this is based on a classification of crops, which are considered in further detail under the heads of Cereals, Pulses, Oilseeds, Fibres, Spices, Drugs and Narcotics, Sugar, Dyes, Vegetables, Fruits, Palms, and Pests of Stored Grain. As it is obvious that such a classification has this disadvantage, that a common polyphagous pest may be placed under more than one of

these headings, a list of crop-pests is provided (Preface, pages x-xxiii), giving a list of crops with the chief pests of each and a reference as to where the description of each pest will be found in the book. Many insects, which are noted as Minor Pests, only appear in this list, not being referred to further.

This book is noteworthy as being the first attempt by a Provincial Department of Agriculture to issue any general and connected account of the numerous pests which take so large a toll of the farmer's produce. It is to be hoped, therefore, that it will be accorded a hearty welcome by, and prove of real use to, those educated members of the cultivating class for whom it has been written. If the price could have been reduced, it would doubtless have been appreciated still more, but we understand that the various leaflets composing the book are available separately to *bonâ fide* cultivators.—(T. B. F.)

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PLANTATION WHITE SUGAR MANUFACTURE.—By W. H. Th. HARLOFF and H. SCHMIDT. Translated by J. P. OGILVIE, F.C.S., and published by Norman Rodger, 2, St. Dunstan's Hill, London, E.C. 1913. Price, 7*s*. 6*d*. net.

THE main object of this little manual of 135 pages is, as the authors say, a discussion of the two methods of clarification of the raw juice, *viz.*, Carbonatation and Sulphitation.

As the success of the manufacture of the white sugar chiefly depends on a true and clear conception of the chemistry of these two methods, no pains have been spared to give a thorough description of the various stages, together with comparative statements of the merits of each of the processes, and a full discussion as to why such and such course is recommended in preference to others. Many of the everyday difficulties have been fully examined and means suggested for preventing or overcoming them.

Great stress has very rightly been laid throughout on the importance of correct liming.

The five introductory chapters on the influence of acids and alkalies, and of the heat, on the constituents of cane juice, on the

colouring substances of the cane; and on the different fermentations, which may occur in the Sugar Factory, should be studied by every one interested in the manufacture of Sugar.

The chapters on the treatment of the muddy juice and the curing of the sugar are all well written, and give much practical information.

Those interested in Indian Factories would do well to take particular note of the effects of indifferent liming, and of the corrosion caused by Sulphurous acid vapours.—(M. N. C.)

LIST OF AGRICULTURAL PUBLICATIONS IN INDIA FROM 1st FEBRUARY TO 31st JULY, 1914.

No.	Title.	Author.	Where published.
	GENERAL AGRICULTURE.		
1	The *Agricultural Journal of India*, Vol. IX, Parts II and III. Price per Part, Rs. 2; annual subscription, Rs. 6.	Issued from the Agricultural Research Institute and College, Pusa, Bihar.	Messrs. Thacker, Spink & Co., Calcutta.
2	Report on the Progress of Agriculture in India for 1912-13. Price As. 8 or 9*d*.	Agricultural Adviser to the Government of India, Pusa.	Government Printing, India, Calcutta.
3	Report of the Agricultural Research Institute and College, Pusa (including the Report of the Imperial Cotton Specialist) for 1912-13. Price As. 7 or 8*d*.	Ditto.	Ditto.
4	Agricultural Sayings of Bengal with Analogous Sayings in Bihar and Orissa. Bulletin No. 1 of 1913. Price As. 6.	P. L. Banerjee ...	Bengal Secretariat Book Depôt, Calcutta.
5	Season and Crop Report of Bengal for 1913-14. Price As. 15.	Issued by the Department of Agriculture, Bengal.	Ditto.
	Season and Crop Report of Bihar and Orissa for 1913-14.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Gulzarbagh.
7	The Agricultural Journal, April, 1914 (issued half-yearly), subscription Re. 1.	Ditto.	Ditto.
8	Names of the field and market garden crops and of the principal fruit and timber trees of the United Provinces. Bulletin No. 30 (revised edition of Bull. No. 4 of the Department of Agriculture, United Provinces). Price As. 7.	Issued by the Department of Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
9	Annual Report of the Agri-horticultural Gardens, Lahore, for 1912-13.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
10	List of Ploughs and other Agricultural Implements recommended by the Punjab Agricultural Department. (Illustrated.) 1914.	Ditto.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
11	Annual Report of the Surat Agricultural Station for 1912-13. Price Re. 1 or 1*s*. 6*d*.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
12	Annual Report of the Dhulia Agricultural Station for 1912-13 Price Re. 1 or 1*s*. 6*d*.	Ditto.	Ditto.
13	Annual Report of the Nadiad Agricultural Station for 1912-13. Price As. 14 or 1*s*. 4*d*.	Ditto.	Ditto.
14	Annual Report of the Dohad Agricultural Station for 1912-13. Price As. 12 or 1*s*. 2*d*.	Ditto.	Ditto.
15	Annual Report of the Dharwar Agricultural Station for 1912-13. Price Re. 1 or 1*s*. 6*d*.	Ditto.	Ditto.
16	Annual Report of the Gokak Agricultural Station for 1912-13. Price As. 14 or 1*s*. 4*d*.	Ditto.	Ditto
17	Annual Report of the Gadag Agricultural Station for 1912-13. Price As. 14 or 1*s*. 4*d*.	Ditto.	Ditto.
18	Annual Report of the Mirpurkhas Agricultural Station for 1912-13. Price As. 7 or 8*d*.	Ditto.	Ditto.
19	Annual Report of the Sukkur Agricultural Station for 1912-13. Price As. 6 or 7*d*.	Ditto.	Ditto.
20	Annual Report of the Alibag Agricultural Station for 1912-13. Price As. 10 or 11*d*.	Ditto.	Ditto.
21	Annual Report of the Poona Agricultural College Station. Price As. 8 or 9*d*.	Ditto.	Ditto.
22	Proceedings of the Agricultural Conference held at Poona in September, 1913. Price Re. 1-4 or 1*s*. 10*d*.	W. W. Smart, I.C.S., Offg. Director of Agriculture, Bombay.	Ditto.
23	The advantages of co-operative sale of cotton.	H. C. Sampson, B.SC., F.H.A.S., F.B.S.E., Deputy Director of Agriculture Southern Division, Madras.	Government Press, Madras.
24	The Fodder Question in Coimbatore.	R. Cecil Wood, M.A., Principal, Agricultural College, Coimbatore.	Ditto.
25	The *Monthly Agricultural and Co-operative Gazette*, February to July, 1914. Price per copy As. 2.	Issued by the Department of Agriculture, Central Provinces & Berar.	Deshsevak Press, Nagpur.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	General Agriculture—concld.		
26	Report on the Season and Crops of Assam for 1913-14. Price As. 8 or 9*d*.	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
27	Season and Crop Report of Burma for 1913-14. Price As. 8 or 9*d*.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
28	Report of the Mandalay Agricultural Station for the year 1912-13.	Ditto.	Ditto.
29	Report of the Hmawbi Agricultural Station for the year 1912-13.	Ditto.	Ditto.
30	A trial of orange stocks at Peshawar (reprinted from the *Agricultural Journal of India* for January 1914).	W. Robertson Brown, Agricultural Officer, North-West Frontier Province.	Messrs. Thacker, Spink & Co., Calcutta.
31	*Quarterly Journal of the Indian Tea Association.* Parts I and II of 1914.	Scientific Department of the Indian Tea Association, Calcutta.	The Catholic Orphan Press, Calcutta.
32	The *Poona Agricultural College Magazine,* Vol. V, No. 4, and Vol. VI, No. 1. Annual subscription Rs. 2, single copy As. 9.	College Magazine Committee, Poona.	Arya Bhushan Press, Poona.
33	Tube Wells—Boring, Sinking, and Working (Second Edition). Price Rs. 5.	T. A. Miller Brownlie, C.E.	Messrs. Thacker, Spink & Co., Calcutta.
34	Rye-grass and clover in India (reprinted from the *Agricultural Journal of India* for January 1914).	W. Robertson Brown, Agricultural Officer, N.-W. F. Province.	Ditto.
35	The *Indian Agricultural World* (monthly). Subscription Rs. 10.	Messrs. P. A. V. Iyer & Co., Triplicane, Madras, S.E.	Commercial Press, Madras.
36	*Indian Poultry Gazette* (monthly). Subscription Rs. 3 per annum.	Issued by the Indian Poultry Club, Lucknow.	Mafusilite Electrical Printing Works, Mussoorie.
	AGRICULTURAL CHEMISTRY.		
37	The Fractional Liquefaction of Rice Starch. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. III, No. 5. Price Re. 1 or 1*s*. 6*d*.	F. J. Warth, M.Sc., Agricultural Chemist, Burma; and D. B. Darabsett, B.Sc., Senior Assistant to the Agricultural Chemist, Burma.	Messrs. Thacker, Spink & Co., Calcutta.
38	The Yield and Composition of the Milk of the Montgomery Herd at Pusa and Errors in Milk Tests. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. III, No. 6. Price Re. 1 or 1*s*. 6*d*.	J. W. Leather, Ph.D., F.I.C., Imperial Agricultural Chemist; and A. C. Dobbs	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	Agricultural Chemistry—concld.		
39	Disintegration of Rice Grains by means of Alkali. Bulletin No. 38 of the Agricultural Research Institute, Pusa. Price 6 annas or 7*d*.	F. J. Warth, M.Sc., Agricultural Chemist, Burma; and D. B. Darabsett, B.Sc., Senior Assistant to the Agricultural Chemist, Burma.	Government Printing, India, Calcutta.
	BOTANY.		
40	The Seed Supply of the New Pusa Wheats (English, Hindi, and Urdu).	A. Howard, C.I.E., M.A., A.R.C.S., F.L.S., Imperial Economic Botanist; and Gabrielle L. C. Howard, M.A., Personal Assistant to the Imperial Economic Botanist.	The Baptist Mission Press, Calcutta.
41	Bengali translation of Mr. Howard's paper on the Yield and Quality of Wheat in India.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
	MYCOLOGY.		
42	Bengali translation of Dr. E. J. Butler's paper on the Ufra Disease of Rice.	Issued by the Department of Agriculture, Bengal.	Ditto.
43	Cultivators' Leaflet No. 44. The Sypmtoms of "Ufra" Disease of Rice.	A. McKerral, M.A., B.Sc., Deputy Director of Agriculture, Southern Circle, Burma.	Government Printing, Burma, Rangoon.
	ENTOMOLOGY.		
44	The Psylla Disease of Indigo. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. IV, No. 6. Price Re. 1-8-0.	A. J. Grove, M.Sc., offg. Imperial Entomologist; and C. C. Ghosh, B.A., Assistant to the Imperial Entomologist.	Messrs. Thacker, Spink & Co., Calcutta.
45	Life Histories of Indian Insects—V (*Lepidoptera*). Memoirs of the Department of Agriculture in India, Entomological Series, Vol. V, No. 1. Price Rs. 2-8-0.	C. C. Ghosh, B.A., Assistant to the Imperial Entomologist.	Ditto.
46	Instructions for rearing Mulberry Silk-worms. Bulletin No. 39 of the Agricultural Research Institute, Pusa. Price As. 4 or 5*d*.	M. N. De, M.R.A., Sericultural Assistant to the Imperial Entomologist.	Government Printing, India, Calcutta.
47	Note on the Green Scale of Coffee (*Lecanium viride*).	T. Bainbrigge Fletcher, R.N., F.E.S., F.Z.S., Imperial Entomologist.	Government Press, Mercara, Coorg.
48	Large Brown Cockroach, Leaflet No. 1 of 1914 (in English and Bengali).	P. C. Sen, Entomological Collector, Bengal.	Obtainable from the Department of Agriculture, Bengal.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	Entomology—contd.		
49	*Dhanerpoka* or Insect Enemies of Rice (in Bengali). Price As. 8.	P. C. Sen, Entomological Collector, Bengal.	Obtainable from the Department of Agriculture, Bengal.
50	Crop Pest Handbook for Bihar and Orissa (including Western Bengal). Price Rs. 4.	Issued by the Department of Agriculture, Bihar and Orissa.	Messrs. Thacker, Spink & Co., Calcutta.
51	Some Remarks on Fishery Questions in Bengal. Fishery Bulletin No. 4 of 1914. Price As. 5.	T. Southwell, Deputy Director of Fisheries.	Bengal Secretariat Book Depôt, Calcutta.
52	Practical Instructions for the Kollegal Mulberry Silkworm rearers.	T. Bainbrigge Fletcher, R.N., F.E.S., F.Z.S., Government Entomologist, Madras.	Government Press, Madras.
53	Some General Methods of Controlling attacks by Insect Pests—Agricultural Methods.	Ditto.	Ditto.
54	Some General Methods of Controlling attacks by Insect Pests—Mechanical Methods.	Ditto.	Ditto.

AGRICULTURAL BACTERIOLOGY.

55	Green Manuring Experiment, 1912-13. Bulletin No 40, of the Agricultural Research Institute, Pusa. Price As. 4 or 5*d*.	C. M. Hutchinson, M.A. B.E., Imperial Agricultural Bacteriologist.	Government Printing India, Calcutta.

VETERINARY.

56	The Curative Treatment of Hæmorrhagic Septicæmia in Cattle by the administration of Iodine and other Notes on Chemiotherapy in Rinderpest and Hæmorrhagic Septicæmia. Memoirs of the Department of Agriculture in India, Veterinary Series, Vol. II, No. 3. Price Re. 1 or 1*s*. 6*d*.	Major J. D. E. Holmes, C.I.E., M.A., D.SC., I.C.V.D., Imperial Bacteriologist, Muktesar.	Messrs. Thacker, Spink & Co., Calcutta.
57	The Vitality of the Hæmorrhagic Septicæmia Organism outside the Body. Memoirs of the Department of Agriculture in India, Veterinary Series, Vol. II, No. 4. Price Re. 1 or 1*s*. 6*d*.	Ditto.	Ditto.
58	Annual Report of the Imperial Bacteriologist for 1912-13. Price As. 3 or 4*d*.	Issued by the Agricultural Adviser to the Government of India.	Government Printing India, Calcutta.
59	Annual Report of the Civil Veterinary Department, Bihar and Orissa, for 1913-14.	Issued by the Veterinary Department, Bihar and Orissa.	Government Press, Gulzarbagh.

LIST OF AGRICULTURAL PUBLICATIONS—*concld.*

No.	Title.	Author.	Where published.
	Veterinary—contd.		
60	Annual Report on the Civil Veterinary Department, United Provinces, for the year ending 30th March, 1914. Price As. 8 or 9*d*.	Issued by the Department of Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
61	Notes on Glanders. Bulletin No. 31, of the Department of Land Records and Agriculture, United Provinces. Price As. 2.	E. W. Oliver, M.R.C.V.S., F.Z.S., Superintendent, Civil Veterinary Department.	Ditto.
62	Annual Report of the Camel Specialist for 1912-13.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
63	Equine Biliary Fever ...	J. F. Valladares, Deputy Superintendent, Civil Veterinary Department, Central Provinces.	Printed in *Parasitology*, May 1914, published by Messrs. Macmillan & Co., Ltd., Bombay and Calcutta.
64	Report of the Civil Veterinary Department, Assam, for 1913-14. Price As. 8 or 9*d*.	Issued by the Civil Veterinary Department, Assam.	Assam Secretariat Printing Office, Shillong.

PUBLICATIONS OF THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA

TO BE HAD FROM

THE OFFICE OF THE AGRICULTURAL ADVISER TO THE GOVERNMENT OF INDIA, PUSA, BIHAR,

and from the following Agents :—

(1) THACKER, SPINK & CO., CALCUTTA.
(2) W. NEWMAN & CO., „
(3) RAI M. C. SARKAR BAHADUR & SONS, CALCUTTA.
(4) HIGGINBOTHAMS LTD., MADRAS.
(5) THOMPSON & CO., „
(6) D. B. TARAPOREVALA SONS & CO., BOMBAY.
(7) THACKER & CO., BOMBAY.
(8) SUNDER PANDURUNG, BOMBAY.
(9) RAI SAHIB M. GULAB SINGH & SONS, LAHORE.
(10) MANAGER, EDUCATIONAL BOOK DEPÔT, NAGPUR.

Annual Report of the Imperial Department of Agriculture in India for the year 1904-05. Price, As. 12 or 1*s.* 2*d.* (*Out of print.*)

Report of the Imperial Department of Agriculture in India for the years 1905-06 and 1906-07. Price, As. 6 or 7*d.*

Report of the Agricultural Research Institute and College, Púsa (including the Report of the Imperial Cotton Specialist) for the years 1907-09. Price, As. 4 or 5*d.*

Report of the Agricultural Research Institute and College, Púsa (including the Report of the Imperial Cotton Specialist) for the year 1909-10. Price, As. 4 or 5*d.*

Report of the Agricultural Research Institute and College, Púsa (including the Report of the Imperial Cotton Specialist) for 1910-11. Price, As. 6 or 7*d.*

Report of the Agricultural Research Institute and College, Púsa (including the Report of the Imperial Cotton Specialist) for 1911-12. Price, As. 6 or 7*d.*

Report of the Agricultural Research Institute and College, Púsa (including the Report of the Imperial Cotton Specialist) for 1912-13. Price, As. 7 or 8*d.*

Report on the Progress of Agriculture in India for the years 1907-09. Price, As. 6 or 7*d.*

Report on the Progress of Agriculture in India for the year 1909-10. Price, As. 6 or 7*d.*

Report on the Progress of Agriculture in India for the year 1910-11. Price, As. 12 or 1*s.* 3*d.* (*Out of print.*)

Report on the Progress of Agriculture in India for the year 1911-12. Price, As. 6 or 7*d.*

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